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ABSTRACT

The goal of the Beginning Teacher Evaluation Study (BTES) is to identify teacher behaviors which are related to student learning. This report focuses on the relationship between the amount of instructional time devoted to mathematics in grade 2 and student achievement in mathematics. Achievement tests were administered in nine classrooms before and after an eight-week interval in which the teachers kept logs of how time was allocated. Six of the classes were directly observed to assess engaged time on task. Multiple regression analyses indicated that instructional time was positively related to achievement although substantial amounts of time and substantial differences in amounts of time were necessary in order to detect this relationship. Students were engaged in on-task activities for approximately half the time allocated to mathematics. (MS)

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A STUDY OF INSTRUCTIONAL TIME IN GRADE 2 MATHEMATICS

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by

Charles W. Fisher

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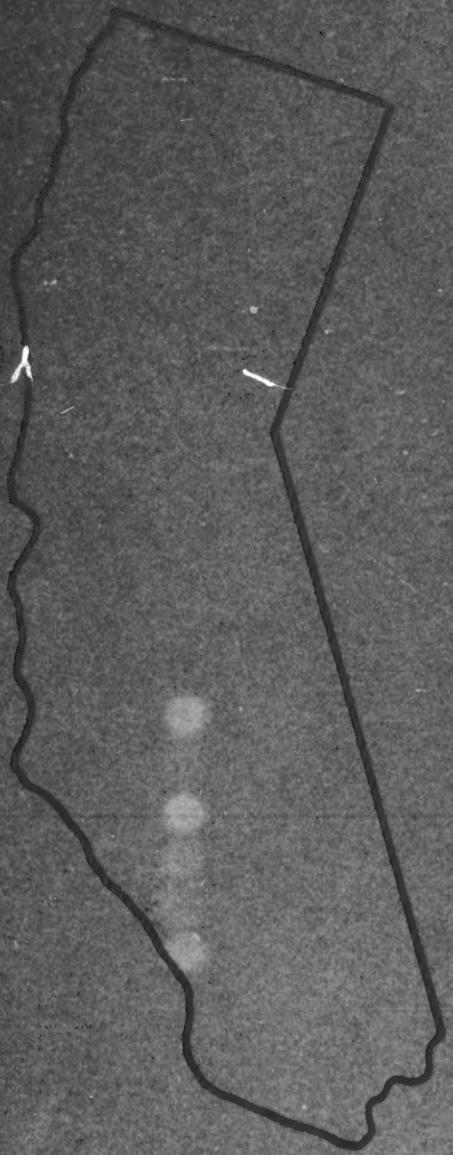

BTES

BEGINNING TEACHER EVALUATION STUDY

Technical Report Series

Technical Report II-3

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PREFACE

The Far West Laboratory conducts research for the California Commission for Teacher Preparation and Licensing through funds provided by the National Institute of Education. The Commission has responsibility for certifying teachers and teacher training programs in the State of California. The research that the Commission sponsors is designed to help them understand what teacher behaviors or instructional activities are beneficial for students. With a reliable knowledge base in this area the Commission and the institutions that train teachers would be better able to provide training experiences based on empirical findings relating teacher behavior to student achievement.

In previous years under the Commission's sponsorship, the Beginning Teacher Evaluation Study (BTES) has conducted empirical and methodological research on teaching which led to a belief that an important element in the study of teaching and learning is instructional time. Time allocated by teachers for learning specific academic subject matter showed considerable variation across classes, and also varied among students within these classes. Further, students appeared to be quite variable in how engaged they were in their assigned academic activities. These major variations in the amount of time students spent learning in different classes called for further investigation. During the continuation of Phase III-A of the Commission's research effort (1975-1976) the Laboratory staff was granted permission to explore some of these temporal factors in instruction. Charles Fisher headed the Laboratory team whose findings are presented in this report.

Richard Marliave, Nikola Filby and Leonard Cahen of the BTES staff contributed many creative conceptual and methodological ideas which helped shape each phase of the study.

During the course of this study encouragement and insight were provided by Annegret Harnischfeger and David Wiley. We are grateful for their longstanding interest in our work, and the constructive comments that they offered.

During the analysis phase, the Laboratory was fortunate to receive helpful comments from a number of distinguished consultants. We thank, in particular, Leigh Burstein, Robert Linn, Richard Shavelson, and Ross Traub for their help.

Jeffrey Moore, Pat Storm, and Mark Phillips of the BTES staff provided reliable support for the substantial data processing effort. Marilyn Dishaw, Faye Mueller, and Fannie Walton coordinated many of the field activities and technical services so necessary for a field study that required the collection and processing of large quantities of data from natural classroom settings. Their efforts, and the efforts of the many field workers who assisted with the data collection are greatly appreciated.

Edna Robnett and Janet Weyrick provided clerical support and typed portions of the report. Deborah Walton patiently and efficiently typed most of the final copy and the many complex tables. Mark Malkas provided editorial assistance. We thank them for their help.

Finally, our thanks and appreciation go to the teachers and students in California schools who continue to support this project by donating

their time and comments. The hard work of many teachers, in addition to their regular classroom responsibilities, makes this research possible. To each of these dedicated volunteers we owe a special thanks.

David C. Berliner
Principal Investigator
Beginning Teacher Evaaluation Study
June 18, 1976

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I INTRODUCTION

The overriding goal of the Beginning Teacher Evaluation Study is to identify teacher behaviors which are related to student learning. It seems clear from previous research that substantial relationships between teacher behavior and student learning are difficult to isolate, and even more difficult to replicate. Although many experiments have been conducted, the greater portion of this research has taken the form of correlational field studies. These studies attempt to characterize classroom phenomena in such a way that the amount of student learning can be predicted from or related to instructional variables.

The major problem has been to define and measure characteristics of instruction that are related to the amount learned. Large numbers of variables have been considered; see the Handbook of Research on Teaching (Gage, 1963), the Second Handbook of Research on Teaching (Travers, 1973) and The Study of Teaching (Dunkin & Biddle, 1974). The results of field studies for the vast majority of these variables have been inconsistent.

Regardless of the variables chosen to characterize instruction, it is clear that the instructional experiences of students differ in both kind and amount. Differences in the amount of instructional time students spend on a particular objective may be an important factor in understanding student learning. Before inquiring further about the relationship between teacher behavior and student learning, it is imperative to know whether students who receive more instructional time in a given subject area exhibit more learning in that area than students who receive less time. If time effects are large regardless of other characteristics of instruction, then the pattern of teacher time allocation must be carefully scrutinized.

In several studies, positive correlations have been found between amount of instructional time and student achievement, although the strength of this relationship has been difficult to assess. In a review of approximately 20 studies, David (1974) concluded that, in studies where the variation in exposure to schooling was extensive, there were consistent positive relationships between exposure to schooling and achievement scores. In studies where the variation in exposure to schooling was minimal, no consistent effects of exposure to schooling were found.

In a school-level analysis, Wiley (1973) calculated average amount of schooling by taking the product of length of school year, length of school day, and average daily attendance rate. Using this index, variation in amount of schooling was strongly and positively related to knowledge acquisition in both reading and mathematics. Another school-level analysis (Karweit, 1976) on the same data confirms this result. However, analysis on several other data sets (reported in the same study) failed to find positive effects for amount of instructional time.

Studies by Bond and Dykstra (1967), Harris and Serwer (1966), and Harris, Morrison, Serwer and Gold (1968), report negative correlations between teacher or student absences and achievement, which could imply that more instructional time is associated with higher achievement. Harris and Serwer (1966) found a positive relation between amount of time in reading instruction and reading achievement. Other studies (Carroll & Spearitt, 1967; Hess & Takanishi, 1974; Stallings, 1975; and Stallings & Kaskowitz, 1974) have assessed the amount of time students <u>actually engage</u> in learning activities in a particular subject area. The results are not overwhelming, but in most cases positive associations were found between time and achievement.

The concept of learning for mastery (Bloom 1968) assumes that time-to-mastery-level and learning are positively related. The research in mastery-learning has generated considerable support for such a relationship. Block (1975), in reviewing studies done at the University of Chicago, found a positive relationship between time and achievement. When time was measured as time actively engaged and on-task, the relationship was described as very strong.

Comments by Shanker (1976) on a recent British study (Bennett, 1976) deal with the relationship between instructional time and student achievement. Although Bennett's primary objective was the examination of student achievement as a function of teaching style, an effect for time was found. Regardless of teaching style, students who spent more time studying a subject also had higher achievement in that subject.

The present brief and incomplete summary of empirical studies of the relationship between instructional time and student achievement reveals some inconsistency. When comparisons were made between instruction and no instruction, relatively consistent positive relations were found. When variability in the amounts of instructional time were relatively small, or when indirect measures of time were used, the results were mixed.

The characterization of classroom instructional variables in terms of time variables has considerable appeal. Carroll (1963) first elaborated a model of school learning wherein many elements of the model were time variables. More recently, Harnischfeger and Wiley (1975) have proposed a model for the teaching/learning process in elementary schools which partitions instructional time into various subject-area and classroom-setting combinations. This latter model has guided the current investigation. Differences in the amount of learning exhibited by similar

students are presumably a function of both the amount and kind of instruction they receive. (The choice of useful kinds of instruction for which to account is a crucial problem in conceptualizing classroom instructional phenomena.) If two groups of similar students are receiving precisely the same kind of instruction, and if mastery of the objectives has not yet been reached, then the group which spends more time on the task will outperform the group which spends less. In other words, differences in learning will be attributable to variation in the amount of instruction, other things being equal. An implicit assumption here is that the learning rates for similar students will be identical, if the instruction is of the same kind. If instruction is not identical for the two groups of students, then amount of learning is a function of the kind of instruction, as well as the amount of instruction.

In studies of the relative effectiveness of different kinds of instruction, these two sources of variance in learning have not always been taken into account. The relative importance of differences in learning time and kind of instruction are not at all clear. If kind of instruction is much more important than learning time in influencing learning, then one would expect to find consistent relations between learning and kind of instruction received. If the factors are about equally important, or if kind of instruction is less important than learning time, then the relation between learning and indices of kind of instruction would appear to be inconsistent when learning time is not accounted for.

Since the educational research literature on teaching indicates the latter situation, it is desirable to assess the effect of learning time independently before trying to establish relations between learning and

kinds of instruction. The overall purpose of this study is to address this issue. Although we are ultimately interested in studying the effectiveness of various teacher behaviors and skills (indices of the kind of instruction), it is necessary first to assess the impact on learning of differences in learning time (amount of instruction).

In field research, it is not possible to separate completely amount of instruction from kind of instruction. In fact, the kind of instruction must be specified at some level before it is possible to discuss amount of instruction. Kinds of instruction might be defined on the basis of content, group size, teacher behaviors, materials used, social climate, or physical arrangements of the classroom, among others. The number of kinds of instruction is practically limitless. Our approach has been to define broad kinds of instruction, and to study the relationship between the amount of instructional time spent in these areas and student achievement.

Teachers allocate time to subject matter areas and, within these, to sub-areas. In Grade 2 mathematics, sub-areas might be addition, subtraction, measurement, geometry, etc. The time a teacher allocates to a subject area sets an upper limit on the amount of in-school instruction a student may receive in that subject area.

Besides allocating instructional time to subject areas, teachers also determine a large number of classroom conditions which characterize the time allocated to a particular subject area. In this study, three conditions were used to define an instructional setting, each was seen as a dichotomy. The facets were: adult involvement (adult directly involved, no adult directly involved), pacing (self-paced seatwork, other), and

group size (small group, large group). These three dichotomous setting variables combined to form eight setting types. Instructional time was allocated to subject areas and, within subject areas, to the eight instructional setting types.

Of the time allocated to a particular subject area, students spent some time engaged in on-task behavior and some time in off-task behavior. From the point of view of the subject area under consideration, this latter time can be thought of an unengaged time.

The general goal of this study was to describe mathematics instruction in terms of both the allocated and engaged time which students spent in each of the instructional settings for each content sub-area, and to relate instructional time to student achievement. More specific goals of the study are stated in the following research questions:

1. How is allocated and engaged time distributed over various content categories?
2. How is allocated time distributed over instructional settings?
3. Of the time allocated to a subject area, how much is engaged time?
4. What are the characteristics of teachers' reported records of allocated time?
5. Do students who have more time allocated to a particular subject area also show more learning in that subject area?
6. Do students who spend more engaged time in a particular subject area learn more in that subject area?

The study reported here is part of a larger research effort. The data available for analysis were part of a larger data set which was collected during the continuation of Phase III-A of the Beginning Teacher

Evaluation Study. The work undertaken in this part of Beginning Teacher Evaluation Study is described in Program Plan for the Continuation of Phase III-A (Far West Laboratory, 1975). In keeping with the goals of Phase III-A, an important function of this exploratory study was to provide experience in collecting and analyzing data on instructional time. The information on time allocation and the utility of various data collection devices is intended to facilitate the design and conduct of Phase III-B of the Beginning Teacher Evaluation Study.

II DESIGN AND INSTRUMENTATION

Design

The objectives of this study were to describe the naturally occurring variations in allocated and engaged instructional time, and to relate these variations to variations in student achievement. No manipulation of classroom conditions or teacher behaviors was attempted. The strategy was simply to assess student achievement in a number of content areas on two occasions; once early in the fall and once late in the fall. In the intertest interval, records of allocated time were kept. The intertest period was chosen in such a way that a maximum interval was available without inconvenience to schools during the first two weeks of classes or the week preceding Christmas vacation. It was also necessary to have approximately ten days at the beginning of the school year for contacting teachers and instructing them in procedures for keeping records of allocated time. These practical time constraints determined that the first testing occasion (referred to as occasion A) take place during the first week of October, 1975. Records of allocated time were kept for eight weeks of instruction, after which the second testing (occasion B) was conducted during the first week of December, 1975.

In addition to the records of allocated time, data were collected on engaged time by direct observation. The data on engaged time served two main purposes; first, it allowed estimation of the proportion of allocated time during which students were actively engaged; and second, it provided data for relating student engaged time to achievement. For the second of these purposes, it seemed particularly important to assess engaged time over several successive days, rather than a sample of days. In this way,

the engaged time in a particular subject area could be assessed relatively accurately. Each class was therefore observed for two weeks. In an attempt to create optimal conditions for the assessment of the relation between engaged time and achievement, additional achievement tests were administered at the beginning of the first observation day and at the end of the last observation day. These testing occasions are referred to as OA and OB respectively. The precedure provided 100 percent coverage by direct observation of in-school instruction for every student during the OA-OB period. Observation was carried out by two observers; therefore only two classes could be observed during any one two-week period. As a result, classes were observed in pairs during successive two-week periods within the A-B period.

In summary, all classes[1] were tested during the first week of October, 1975 (occasion A); allocated time records were kept for eight weeks; and then all classes were tested again during the first week of December, 1975 (occasion B). Engaged time for each class was assessed by direct observation during a two-week period, with associated pretests and posttests (occasions OA and OB). The timing of the observation periods was staggered in such a way that pairs of classes were observed during the same two-week period. All classes were observed between testing occasions A and B.

Measures of Mathematics Achievement

The measures of mathematics achievement used in this study are a subset of the mathematics scales being developed by the staff of the Beginning Teacher Evaluation Study. Interim versions of scales being

[1]The data set described here is a subset of the data collected during the continuation of Phase III-A of the Beginning Teacher Evaluation Study (Far West Laboratory, 1975).

refined for Phase III-B were used. The development history and data from pilot testing of the items are included in Technical Report III-1: Development and Refinement of Reading and Mathematics Tests for the Study of Reading and Mathematics Instruction in Grades 2 and 5 (Filby & Dishaw, 1975).

Three scales measuring achievement in areas commonly taught at the Grade 2 level were chosen. The scales were labeled place value, subtraction without regrouping, and addition with regrouping, and had 15, 10, and 10 items respectively. All three measures were group-administered multiple-choice tests. These scales were administered at occasions A, OA, OB, and B. The scores obtained at A and B were used in conjunction with time variables assessed over the eight week interval. The items administered at A and B were identical. (Examples of these items are included in Appendix A.) Since the same scales were to be administered on four occasions in a relatively short time period, and since the scores from occasions OA and OB were to be analyzed independently of the scores from occasions A and B, the items given on occasions OA and OB differed from those given on occasions A and B. The items were logically parallel, in that the stems and format were identical. The numbers in about two thirds of the items were changed to limit the possible effects of memory.

The internal consistency reliability coefficients for each of the scales at each testing occasion are displayed in Table 2.1. Entries in the table were computed on all subjects with complete data for any given testing occasion. All scores were corrected for guessing using the standard correction procedure (Thorndike, 1971). Although the tests were short, the internal consistencies were reasonably high. The tests were

Table 2.1

Reliability Coefficients (Cronbach's Alpha) for Mathematics Subscales at Each Testing Occasion

Scale	Number of Items	Occasion A		Occasion B		Occasion OA		Occasion OB	
		α	N	α	N	α	N	α	N
Place Value	15	.64	105	.75	112	.61	117	.81	112
Subtraction Without Regrouping	10	.56	105	.74	112	.60	117	.69	112
Addition With Regrouping	10	.57	105	.74	112	.60	117	.70	112

Table 2.2

Intercorrelations among the mathematics measures at each of four testing occasions

	Occasion A			Occasion B			Occasion OA			Occasion OB		
Scale	1	2	3	1	2	3	1	2	3	1	2	3
1 Place value	1.00	.33	.50	1.00	.47	.49	1.00	.59	.47	1.00	.46	.49
2 Subtraction without regrouping		1.00	.23		1.00	.32		1.00	.27		.100	.24
3 Addition with regrouping			1.00			1.00			1.00			1.00

quite difficult on occasion A, which tended to reduce the variances. This tendency probably kept the reliabilities somewhat lower for occasion A as compared to the other occasions.

Given their reliabilities, the scales were relatively highly intercorrelated. The intercorrelation between the place value scale and the subtraction without regrouping scale (see Table 2.2) increased somewhat over the A-B time period. Correlations among the other scales remained fairly constant.

Measure of Academic Status

In addition to the mathematics achievement scales, a large battery of reading tests was administered to classes in the study. By summing the 340 reading item scores (corrected for guessing), a measure of academic status, was calculated for each student. The items from which these scores were derived were administered at the A testing occasion. Items were all group-administered, and the vast majority had a multiple-choice format.

Scores for academic status ranged from a low of 1 to a high of 322 for the students in this study. The mean and standard deviation were 113 and 81 respectively. No internal consistency reliability coefficient was available for the variable, but the value was certainly in excess of .95. Values of Cronbach's alpha (Cronbach, 1951) were available for three of the major subcomponents of academic status. For 128 decoding items, 65 word structure items, and 124 comprehension items, the Cronbach's alpha estimates were 0.96, 0.92, and 0.97 respectively. Since the components of academic status were highly correlated, it seems clear that the academic status measure had a very high internal consistency. This measure,

based on a wide variety of reading items, was used as an index of general academic aptitude in analyses relating instructional time and student achievement.

Process Variables

The process data consisted of measures of both allocated and engaged time spent in particular mathematics content areas. Within content areas, several instructional settings were distinguished. Data were collected for every student in each of the participating classes. Allocated time was assessed by a log-keeping procedure and engaged time was assessed by direct observation. The present section of this report describes the subject-matter and setting categories, the teacher log procedure, and the direct observation procedure. The final portion of this section describes procedures used in deriving two alternative indices of student engagement.

Subject-matter and instructional setting categories. Since instruction is planned and implemented by content area, and since student achievement is most often differentiated by content area, instructional time was first partitioned by content category. Subareas of mathematics (e.g., addition with regrouping, subtraction with regrouping, place value) constitute the categories. Mathematics content categories were developed at two levels; general and specific. They were derived from a logical analysis of Grade 2 mathematics objectives, textbooks, and curriculum materials. The original categories were modified and refined by classroom teachers during piloting.

For Grade 2 mathematics, 10 general content categories were defined.

These break down into twenty-seven specific content categories.[1] (All content categories are listed in Appendix B.) Specific content categories were developed so that allocated time could be recorded in relatively narrow categories. However, it was not possible to use all of these categories in direct observation. As a result, the general content categories were also devised. In some cases, a general content category corresponds to one specific content category; in most, several specific categories make up one general category.

Within the content categories, broad instructional settings were defined by three fundamental instructional characteristics: adult involvement, pacing, and group size.

The teacher-involvement facet had two elements. Settings in which students worked directly with a teacher (or other adult) were distinguished from settings in which a teacher's primary attention was not directed toward the students being considered. This facet is important because the impact of a teacher's interactive behaviors and skills operates in the former but not the latter type of setting. (The term "teacher" was used in the broad sense, to include any adult directly involved in instruction.) If a class was divided into two groups at some point in time, and one of the groups was engaged in an addition drill with the teacher while the other group was doing seatwork, the students in the drill activity were in a setting with direct teacher involvement. The students who were doing seatwork were in a setting which did not involve a teacher directly, even though the teacher may have occasionally addressed one or more of them. If students were engaged in seatwork,

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[1]The category systems had a primary use related to the study of test reactivity (see Far West Laboratory, 1975). For this purpose the categories were designed to encompass the entire Grade 2 curriculum.

and the teacher's main activity consisted of going from student to student to check or explain work, the teacher was characterized as directly involved, even though he did not interact with all students in the group.

The pacing facet was included to distinguish between settings in which students proceeded at their own pace and settings in which they worked at a pace determined by the teacher (or some other characteristic of instruction). Pacing is very much a matter of degree; students never completely determine their own pace, nor is pace totally determined by external factors. Nevertheless, instructional settings vary considerably in this respect; and, as a result, the rate of student learning may be strongly affected. As a crude operationalization of pacing, a distinction was made between seatwork and group work. Seatwork is the most frequently occurring setting in which students have relatively high control over pace; group work is the situation which is most externally paced.

The third facet of instructional setting was group size. This facet has been the subject of much research and has great intuitive appeal. It was included here, not because of its potential direct effect on learning, but because different group sizes provide the opportunity for very different kinds of student activities, teacher behaviors, and group climates. The mere fact that a student is working in a small group does not imply that a particular kind of instruction will occur; it does act as a necessary (but not sufficient) condition for certain highly-valued teacher behaviors. For instance; the smaller the group, the more closely a teacher can approximate a tutoring situation with each student. However, a lecture to a group of five children is probably very much like a lecture to a group of thirty-five children. Group size, like the other

facets of setting, was coded as a dichotomy. Large groups were defined to contain ten or more students; small groups, nine or fewer. (Pilot experience showed that a lower value for the upper bound of "small groups" would have provided very little discrimination among actual classroom groups.)

Teacher logs. The teacher logs were developed by the staff of the Beginning Teacher Evaluation Study. The logs served as the primary source for collecting data on allocated time, both for the study of instructional time and for the study of reactivity (see Far West Laboratory, 1975). The development of practical methods for collecting information on allocated time was, in itself, an important objective of the work carried out during the continuation year of Phase III-A of the Beginning Teacher Evaluation Study.

The log procedures are the result of pilot work conducted in three year-round schools during July and August, 1975. A wide variety of procedures were considered, including many suggestions from participating teachers. The goal of pilot testing was to have teachers try a prototype log and, tapping their reactions and suggestions, to develop a workable format for acquisition of a maximum of accurate information with minimum inconvenience to the teacher. (Teachers recruited for the pilot tests were told that procedures were being developed for recording the content covered in mathematics for each student in their classes. They were also told that the information would be used to relate student achievement to the content which had actually been covered during classroom instruction.)

The first log that was tried had a checklist format. Content categories were listed, and teachers were asked to indicate daily whether

students had worked on the categories. Teachers recorded the amount of time, using the symbols N (not at all), S (from one to five minutes), and A (any time period greater than five minutes). A relatively detailed list of categories was included. If teachers felt that too many categories had been listed, they were asked to suggest categories which could be collapsed. In classrooms where teachers grouped students for instruction, logs were kept for student groups. Teachers with highly individualized programs kept one log for each of four students. In the latter case, students were selected from the high, middle, and low quarters of the student-ability range. During the pilot period, teachers kept logs on both mathematics and reading instruction.

Six teachers (three 5th grade and three 2nd grade) from a year-round school in Hayward, California piloted this procedure for two weeks. As they had individualized programs, the logs were kept for target students. After two weeks, about half the teachers found that keeping logs of this type took from five to ten minutes per day. The remaining teachers took longer -- from ten to twenty minutes per day. With more practice and greater familiarity with the content categories and the format, it was estimated that all teachers could complete logs in about ten minutes per day.

The procedure worked well in the Hayward program; however, it provided data on only four students per class. The teachers had several constructive comments. They found the content categories relatively familiar and easy to use. Most felt that the "N" notation was a waste of time and dropped it completely. A few noted some teacher benefits from keeping logs: it reminded them specifically of what they were or were not covering, and

the students for whom logs were kept were pleased and motivated by the attention.

At this point, those teachers with highly individualized programs were asked to divide their students into three ability groups and to keep a weekly record of content covered for each group. They reported difficulty in grouping students. In addition, content categories which they noted as "covered" were not necessarily covered by all students in a particular group.

At an additional pilot site in Fairfield, California, teachers also kept logs as described above. Here, two fifth grade teachers were involved in a team-teaching situation. Their classes were grouped by mastery level, and they found it convenient to keep the logs by student group. After these teachers had kept logs for approximately ten days, they were asked to augment the log to reflect instructional settings as well as content covered. At this point, it became clear that information on individual students was not necessary if the class were grouped. The teachers in Fairfield suggested a log format which was a variation of a lesson plan, rather than a checklist. This new format was tried and found to be workable. However, it was clear that the organization for instruction varied considerably from class to class, requiring that the procedure for log-keeping remain flexible.

As a result of experience in these classrooms, one procedure was developed for classes which used various grouping strategies, and another for classes that were highly individualized.

Teacher log procedure. The experience gained during the pilot was used to refine the record keeping procedures. All participating teachers maintained

records of time allocated to mathematics instruction. These were referred to as "teacher logs." The logs provided information on content covered and settings for mathematics instruction, on a daily basis, for groups of students in each class. The time allocated to each instructional setting was recorded, with one or more content categories associated with that setting. In highly individualized classes, teachers recorded the content covered and settings used for each student during mathematics instruction.

The teacher log format is presented in Figure 2.1. Each one-page log covered one week of instruction for a single group of students. The names of the students in a given group were designated on the attendance/group composition sheet (shown in Figure 2.2). Each teacher listed his class roster on the left hand side of the attendance/group composition form. For a given week, the teachers then designated the mathematics instruction group for each student and the daily attendance. This procedure allowed for different grouping patterns in reading and mathematics when logs were being kept for two subject matter areas. It also allowed for changes in the composition of student groups.

Mathematics content was recorded according to the list of categories in Appendix B. Teachers referred to the list to find appropriate codes for content categories that best described the instruction. Teachers were also provided with glossaries which contained examples of each of the content categories, and were individually trained in the log-keeping procedure. Practice logs were kept by each teacher for up to two weeks before data collection began. The training and glossary were intended to ensure reliable categorization of content from teacher to teacher. Content was recorded using the specific content categories.

TEACHER _____ GRADE _____ READING _____ MATH _____ GROUP _____ WEEK _____

TIME:

NDAY	CONTENT	
	Adult / No Adult and Seatwork / Other	
	MATERIAL	
ESDAY	CONTENT	
	Adult / No Adult and Seatwork / Other	
	MATERIAL	
DNESDAY	CONTENT	
	Adult / No Adult and Seatwork / Other	
	MATERIAL	
URSDAY	CONTENT	
	Adult / No Adult and Seatwork / Other	
	MATERIAL	
DAY	CONTENT	
	Adult / No Adult and Seatwork / Other	
	MATERIAL	

Figure 2.1
Teacher Log Format

Figure 2.2

ATTENDANCE/GROUP COMPOSITION RECORD

READING MATH (circle one) Teacher_____ Grade_____

Week of_____

Student's Name	Group	M	T	W	Th	F
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						
11.						
12.						
13.						
14.						
15.						
16.						
17.						
18.						
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31.						
32.						
33.						
34.						
35.						

In classroom situations, content tended to change more quickly than setting. For this reason, several content categories were often designated for one instructional setting. The starting and ending time for each setting was recorded, thereby providing a record of the instructional time allocated to the content covered in each setting. If several different categories were recorded for one setting, (and therefore one time period), then the teacher specified the time devoted to each content category whenever possible. Otherwise, the total period of time was divided by the number of content categories, yielding an estimated time allocated to each category.

The defining characteristics of instructional settings (adult involvement, pace, and group size) have been described above. Direct involvement of an adult covered a range of activities from lecturing to monitoring independent seatwork. "Adult" referred to any teacher, student teacher, or aide. The same adult was not classified as directly involved in more than one setting at a time. Therefore, an adult would not be classified as directly involved in monitoring seatwork if that were a secondary function of the adult.

Regarding the pacing facet: "seatwork" referred to any setting where students worked independently. Two or more students working together, or an adult tutoring one student, was classified as a group-work setting.

The group size facet was not recorded by teachers. This categorization was made by coders when the teacher logs were returned to the Laboratory for processing. Group size was ascertained by checking the number of students in a particular group on the attendance/group composition form.

In addition to the information noted above, teachers provided a brief description of the materials used in each instructional setting: the name of a textbook and the pages covered, worksheets used for seatwork assignments, and the like.

In summary: for a given week, each teacher recorded how students were grouped for mathematics instruction on the attendance/group composition form. Daily absence records were kept on the same form; and if group composition changed during the week, the changes were also reported. On the teacher log form itself, teachers kept daily records for each student group. For each day, time periods were blocked off by vertical lines (drawn by the teacher). The beginning and ending times for a setting were recorded along the top of the form. For each setting, teachers recorded adult involvement, pacing, materials, and content categories. In this way, varied instructional patterns could be recorded on the same form. (Examples of completed teacher logs and attendance/group composition sheets are included in Appendix B.)

Where teachers grouped students for instruction, this procedure worked well. However, where instruction was highly individualized, variations were adopted. This most often required the keeping of records for individual students; or, where teachers operated a number of "activity stations," records could be kept for each station.

Since the log procedures were quite new, relatively little was known before the study about their measurement characteristics. Therefore, in order to obtain independent assessments of allocated time, two additional data sources were used. First, Far West Laboratory coders, who transferred the raw teacher logs into machine-punchable formats, spent one day in each

classroom. During that day, the coders completed a log for the mathematics instruction that occurred. This log was then available for comparison with the teacher log for the same day. Since there was only one day of coder log per teacher, these data were treated in a clinical manner. Second, at the end of each day of direct observation, the Far West Laboratory observers completed logs. From this data source, seven to nine days of logs were made available for comparison with each teacher's log. The results of these comparisons are presented in Chapter IV.

Direct observation. Data collection by direct observation served two major purposes. First, direct observation of instruction over a two week intertest period provided the basis for relating achievement to amount of engaged time. Observation of all school instruction during this interval eliminated the problems arising from sampling of a few instructional occasions from a relatively long intertest interval. The observation system was intended to capture all instruction relevant to mathematics in terms of engaged time in content and setting categories, which could then be related to achievement measures. The second purpose of the observation system was to provide independently collected data to compare with the allocated time data from teacher logs. However, since observers assessed engaged time and teachers reported allocated time, quantitative comparison of these two sources (for purposes of determining the reliability of teacher logs) was difficult. So, in addition to their daily observation task, observers completed an allocated time log of the day's instruction. These were used for comparison to the teacher logs.

In the development of this observation system, the selection of the level of specificity with which to describe classroom phenomena was a

difficult problem. The usefulness and practicality of a content- or setting-category can vary tremendously depending upon the number of facets involved in its definition. The more specific the categories, the more difficult the coding of process data, especially when data are to be collected on every student in a given classroom. A decision must be made to collect either more specific information for a smaller number of students or less specific information on a larger number of students.

In this case, the decision was made to describe instructional settings at a relatively global level, in terms of three dichotomous facets (adult involvement, pacing, and group size). Within these settings, content was noted in relatively specific categories. (The setting facets and content categories have been described above. Although data were collected for both reading and mathematics instruction, only the data pertaining to mathematics instruction is used for this report.)

During July and August, 1975, Far West Laboratory staff observed teachers of Grades 2 and 5 in year-round schools operating in Fairfield and Hayward, California. On this occasion, attempts were made to code content in reading and mathematics in a large number of specific categories. It soon became clear that content changed very quickly when specific categories were used. For example, teachers handed out seatwork dittos which included work on a relatively large number of specific mathematics content categories. Clearly, it was impractical to record the amount of time spent on each specific category by each student.

After trying several alternatives, this problem was resolved by redefining the content categories. Since the observation covered a two week period in the fall of the year, attention was restricted to a few

specific content categories which were commonly taught during that portion of the school year. The other content areas were collapsed into one broad category. The observation categories chosen for mathematics were:

1. addition without regrouping,
2. addition with regrouping,
3. subtraction without regrouping,
4. subtraction with regrouping,
5. place value and expanded notation,
6. other.

The relationships among the specific, general, and observation content categories are shown in Appendix B.

Focusing on a small number of content categories made observation much more practical, but did not solve all problems. Experience during piloting indicated that content still changed more quickly than setting variables (for example, group size or adult involvement). Rather than attempt a perfect fit between content categories and the setting variables, more than one content designation was allowed for any particular combination of setting descriptors. These setting descriptors (adult involvement, pacing, and group size) were identical to those used in the teacher logs.

Some illustrations of how settings were coded may help to clarify the meaning of the setting descriptors. Consider the adult involvement setting facet. Suppose a teacher has his or her class divided into two activity groups: a mathematics group led by the teacher, and a group of students doing seatwork. For all of the students in the mathematics group, the instructional setting is characterized by the direct involvement of the teacher, while the setting for the remainder of the students entails no direct teacher involvement, and would be so coded. The status

of the second group would not change even if the teacher occasionally answered questions for students in the seatwork group. However, if the whole class was doing seatwork, and the teacher's primary activity was monitoring students for the purpose of giving feedback and explanation, then the setting would be coded as having a teacher directly involved. In many classes, student-teachers and aides also engaged in direct instruction of students, and for coding purposes no distinction was made between these adults and "teachers." (This adult-involvement setting facet was coded by using "A" to represent cases where the teacher was directly involved and "N" for all other cases.)

Instructional settings were also differentiated in terms of pacing. A distinction was made between situations where each student controlled the pace at which his work proceeded and situations where the student did not. The vast majority of cases where the student has relatively high control of his own pace occurred in independent seatwork. Pacing was operationalized as seatwork (coded "S") and everything else (coded "O").

In addition, settings were differentiated in terms of group size. Small groups (coded "L") were defined as having nine or fewer students. Settings with ten or more students working on the same activity were designated as large groups (coded "H").

The basic strategy of the system was to code all instruction in mathematics (and reading) for each student in a classroom. This was done by tracking the time students engaged in particular settings in terms of teacher involvement, pacing, and group size, and subsequently coding the content covered within each setting. (For each setting, one or more content categories were recorded.)

Experience during piloting indicated that one observer could monitor classes of up to thirty students for this information. However, it was essential that the observer know the general routine of the classroom, the materials, and also be able to distinguish one student from another rapidly. These requirements were met by having an observer spend one full day in a class before data collection began. This procedure allowed teacher and students to become accustomed to the observer, and provided the observer with practice in each classroom.

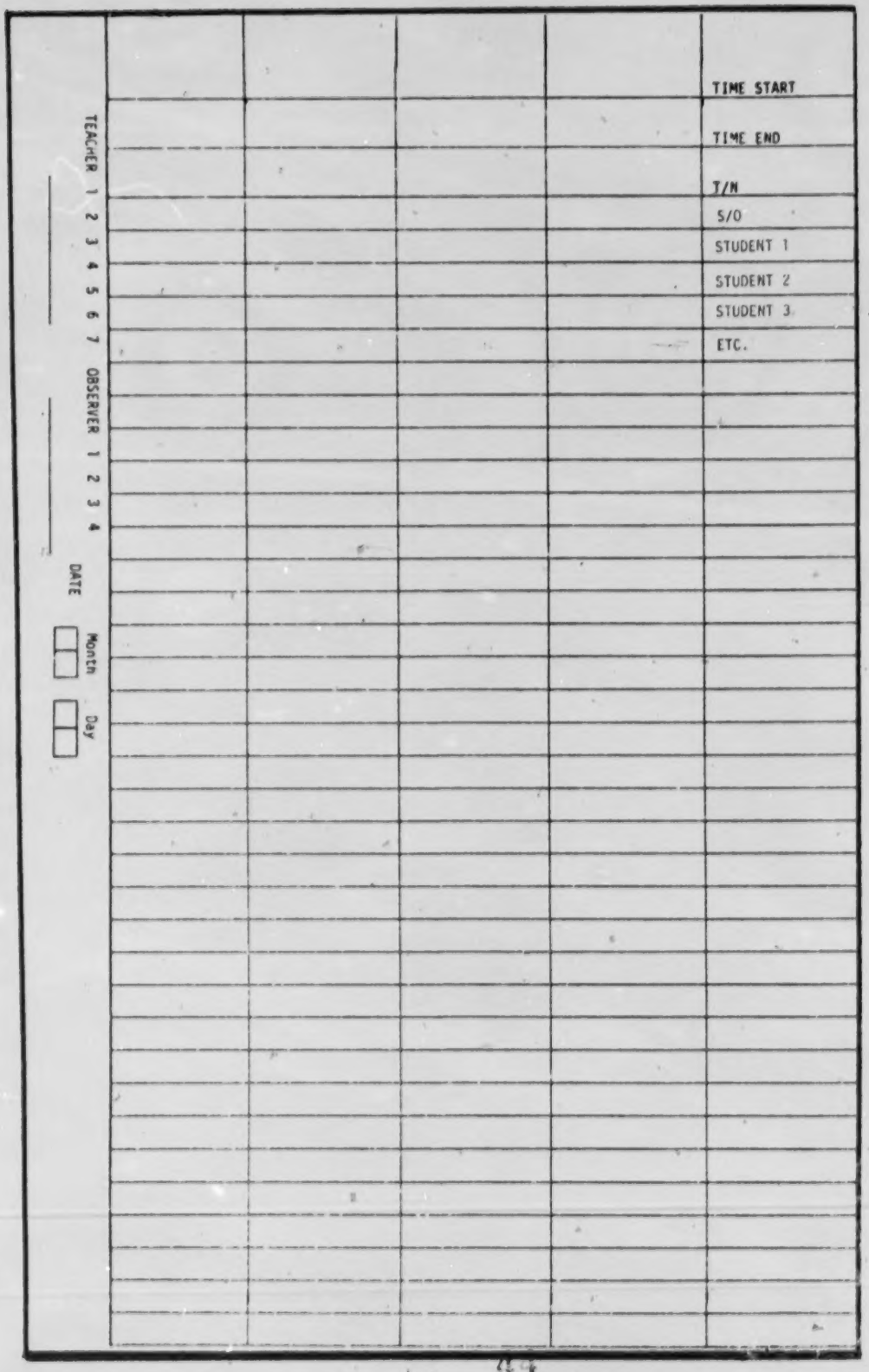
Direct observation procedure. Observers collected data over two consecutive weeks in each classroom. One day was required for memorization of the students' names, and familiarization with the general classroom routine. The remainder of the time (approximately 9 days) was available for official data collection.

Once the observer was familiar with the classroom organization and students, the procedure was relatively straightforward. The observer entered the classroom with the students each morning and used the observation coding form (Figure 2.3) to record data. (The coding form used in the field was 8-1/2 inches by 14 inches. It has been reduced in size for display in Figure 2.3.) Students' names were placed in the columns. The four lefthand columns were used for recording starting and ending times, teacher involvement and pacing codes.

The form was used in the following way. The observer noted the starting time for any group setting wherein mathematics (or reading) was the content. All times were recorded to the nearest minute. Teacher involvement and pacing for each group were then coded in the appropriate columns. Finally, the content was coded in the cell below the name of each student in that setting.

Figure 2.3

Observation Coding Form
(Reduced from 8-1/2" X 14")



If the content was the same for all students in a setting, then the content was coded for the student appearing first in the list; and a horizontal line was drawn across the appropriate cells for each of the other students in that group. This indicated that the content code was the same for all students in that group. In the simplest case, where a setting came to an end at a particular time for the whole group, the ending time was recorded. If some students in that setting covered different categories of content, then those categories were coded under the names of the appropriate students. If one or more of the students in a setting left that setting, then the end time was entered in the cell for that student directly under the content code. In this way, all students who started out in the same setting could leave it at different times and still be accounted for. If a student entered an existing setting after it started, then the observer coded that student's start time under his name and then coded the content. Thus, if a cell for a particular student began with a time, it was implied that the group time entered in the far left column did not apply to that student. If the last entry in a cell for a particular student was a time, it implied that he left the group before it ended and the end time for the setting (second column from left) did not apply for that student. Similarly, if a student started off in setting A, changed to setting B, and then returned to setting A again, the sequence could be coded. The cell under the student's name might contain a content code, a time, another time, a content code, and a third time. This configuration would represent a case where the student started the setting with the whole group and was working on the content listed first. This work continued until the first time listed

in his cell, at which point the student changed to another setting. At the second time listed in the cell, the student returned to the first setting and worked on the content listed next in the cell. The final time recorded in the cell represents the point at which the student left the setting again, and, in the example being considered, the setting continued to exist after the student's second departure. The time during which the student was not in the setting being discussed could be accounted for by looking in another row on the form (that is, in another setting). However, note that if the interim setting did not involve mathematics (or reading), then no entry would have been made for that interval.

To recapitulate: each row on the form represented a setting as defined by teacher involvement and pacing. Several rows could be active at any one time. Content and information which was associated with individual students (as opposed to groups) was recorded in the columns of the form under the names of the particular students. In this way, one observer kept track of all the students in the class. Note that when a student was working on content which was not recordable within one of the categories of mathematics (or reading) as defined for this study, no codes were recorded.

Group size was not necessarily included in the set of codes. However, the group size for any setting could be recovered from the codes already described. For a particular student at a particular time, group size for the setting could be determined by examining the row in which the student was included and counting the number of students in the row at the same point in time. (As previously stated: for purposes of analysis, group size was considered a dichotomy; small groups defined as having nine or

fewer members, large groups as having more than nine. Since the exact group sizes were available from the raw data, this cutting point could be easily changed for additional analyses.)

The space at the right of the sheet was used for comments or clarifications as they were required. Forms with the names of students were printed for each class. The names of teacher and observer and the date of observation were also recorded on each form.

In carrying out the observation routine, it was necessary for the observer to move about the room to look at materials being worked on by students. Experience showed that the content coding required a thorough knowledge of the materials actually being used by students. This was especially true in cases where the program was highly individualized.

The observation procedure was designed to collect information on engaged time. If students were not engaged in the task at hand, then time was subtracted from each setting for each student depending upon how much time that student was unengaged. When time was subtracted for unengagement, it was done so in multiples of one minute; momentary inattention was ignored.

Engagement was judged by the observer with the aid of several guidelines. When students were working on tasks which required an overt response, engagement was relatively easy to judge. When students were working on tasks which did not involve overt responses, the situation was somewhat more difficult. In the latter cases, observers used student eye contact and body position as indicators of engagement. If a student was in a discussion group, watching the various speakers in turn and apparently following the discussion, then the time was considered engaged time. If a student was discussing an unrelated topic with other students,

or was clearly not attending to the task, then the time was considered unengaged time. The distinction was fairly crude; students were considered unengaged only when the situation was unambiguous.

At the end of each observation day, the raw data on the observation coding form were transferred to standard coding booklets by the observer. In this way, a set of engaged times was generated for each student, describing his mathematics (and reading) instruction for the day. For mathematics, with six observation content categories and eight combinations of the three dichotomous setting variables, there are 48 content-by-setting combinations. The standard coding booklets contained a vector of 48 engaged time entries for each student, summarizing the engaged time in mathematics for that particular day. The observation data on this form were punched on computer cards for further processing.

Observer reliability. The observation data were collected by two observers. After approximately two weeks of training, the observers simultaneously collected data in two classrooms over a four day period for reliability purposes. Both observers went to Class A for two full days and then to Class B for two full days. The data obtained in this period were transferred to the standard coding booklet; and times were collapsed over days, classes and setting codes, so that total engaged times were available for each student for each content category from each of the two observers. Interobserver correlations were computed, and showed good agreement on most content categories.

After this post-training check, the observations were carried out in the study classrooms. This required approximately six weeks. Following the data collection, the observers returned to the same two classes and simultaneously observed Class A for 2 days and Class B for one day.

These data were processed along with those collected at the post-training period. The data were collapsed over the seven days (four pre and three post) of observation, yielding total time in content-by-setting combinations for each student from each observer.

The interobserver correlations for each content-by-setting combination are presented in Table 2.3. For the calculation of interobserver agreement indices, the students from both classes were pooled, yielding a sample of 45 students. Some setting-by-content combinations were rarely (or never) observed during the seven day period. This resulted in some correlations being calculated on distributions with very little variance. In some cases only one student had a non-zero engaged time. This accounts for many of the low correlations. Where the distributions were all zeros for both observers, two dashes appear in the table. These represent cases of perfect agreement; that is, neither observer recorded any time for any student in that content-by-setting combination. Where there was a reasonable amount of time recorded, the correlations were relatively high, indicating that engaged time in content-by-setting combinations can be reliably recorded by different observers.

The setting information was used for descriptive purposes only. Time in content areas was used both for descriptive purposes and in analyses of time in content with achievement. The bottom row of Table 2.3 presents the interobserver agreement when the data were collapsed over setting. Note again that the coefficients were relatively high. (The coefficient for subtraction with regrouping (0.47) was an exception. Very little time was recorded in this content category and the low correlation reflects the lack of variance.)

Table 2.3

Interobserver correlations for content category by setting combinations. Data were collected in two classrooms over a total of seven school days. Four of the days occurred after training but before the study data were collected, while three of the days occurred after the study data were collected.

	Content Categories					
Settings	Addition Without Reg.	Addition With Reg.	Sub. Without Reg.	Sub. With Reg.	Place Value	Other Math.
ASH	.75	.00*	.70	.00*	.59	.78
ASL	.00*	--	.00*	--	.00*	.00*
AOH	.00	--	.00	.93	--	1.00
AOL	.88	--	.79	--	--	.98
NSH	--[a]	--	--	--	--	--
NSL	.78	--	--	--	--	.00*
NOH	--	--	--	--	--	--
NOL	.77	--	.00*	--	--	--
All settings combined	.71	.00*	.87	.47	.69	.93

Note: Number of subjects = 45

A = adult involved
S = seatwork
L = low group size
N = no adult involved
O = other (non seatwork)
H = high group size

[a] A -- indicates perfect agreement between observers but all students had zero recorded time.

* These coefficients represent cases where only a few students had non-zero times assessed by one or both observers. One of the starred coefficients has 5 students with non-zero times, while the others have 3 students or fewer with non-zero times.

Student engagement rates. Although the direct observation procedure provided information on the amount of engaged time students spent in a two week instruction period, there was no direct information available on student engagement rates. Two methods of estimating engagement rates were tried.

As noted earlier, observers completed a log at the end of each day of observation. This log contained the amount of allocated time in mathematics (and reading) for students in the class for a particular day. These daily logs were coded and punched. (Mathematics logs and reading logs were punched separately.) For most classes, there were seven full days of instruction for which both allocated time from observer logs and engaged time from direct observation were available (one class had six days). For each student, the total time allocated to mathematics and the total engaged time in mathematics were calculated (over the 6 or 7 day period). An observed engagement rate was then computed for each student by taking the ratio of total engaged time in mathematics to total time allocated to mathematics.

Since the observed engagement rate could be computed only after extensive observation of each student, it was desirable to find an alternative procedure that would be less expensive. The results of this work were to inform the Beginning Teacher Evaluation Study Phase III-B design, so cost and practicality considerations were important.

An alternative procedure was based on adjusted teacher ratings of student attentiveness. Teachers were asked to rate each student in terms of the percent of the time which the student paid attention during class. These ratings were made twice: once for instructional settings where an

adult was directly involved, and once for settings where no adult was directly involved. The percent attentiveness ratings were made by placing a check in one of nine categories, where each category represented an increment of 10 percent on a 0 percent to 100 percent scale. (The directions to teachers and the two rating forms are included in Appendix C. By an oversight, the category representing 31 to 40 percent was omitted from the form.)

The teacher ratings of attentiveness were assigned the mid-category value; that is, a check in the 81-90 percent category was assigned a value of 0.85. This provided a distribution of attentiveness scores for each class. However, comparison from one class to another would be hazardous, since errors due to teachers' tendencies to rate high or low would appear as between-class differences. In an attempt to correct for possible teacher bias, class estimates of mean engagement were made.

However, the estimates were based on data collected during instruction in reading. An observer visited each class for one day. During the reading instruction periods, the observer counted the number of students engaged and the total number of students nominally working on reading. This procedure was repeated every four minutes. In this manner, average class engagement estimates were calculated. The results of this procedure are shown in Table 2.4.

These average class engagement estimates were used to adjust the teacher ratings of student engagement. The adjustment was made in such a way that each adjusted class mean was equal to the average class engagement estimate. The adjustment is specified in the following equation:

Table 2.4

Estimates of Average Class Engagement

Class ID Number	Average Number of Students Observed	Number of Time Samples	Time Sample Interval (Mins)	Average Engagement[a]
1	15	18	4	.44
2	11	44	4	.49
3	19	27	4	.25
4	7	41	4	.59
5	15	23	4	.41
6	16	31	4	.51

[a]These estimates were calculated from one day of observation per class. In all cases data were collected during class time which was allocated to reading activities. Since teachers allocate varying amounts of time to reading, the time period covered by the observation differs considerably. The observers counted the number of students engaged at four minute intervals. The observers subsequently recorded the number of students engaged, the time, and the number of students in the classroom who were part of the BTES study and who were nominally working on reading activities. The average engagement was calculated by summing the number of students engaged over the total number of time samples and dividing by the sum of the number of students in the classroom being followed by BTES and nominally working on reading activities. No distinctions have been made between subareas of content within reading or setting combinations.

$$Y_{ij} = \frac{\overline{E_j}}{\overline{R_j}} R_{ij}$$

where Y_{ij} is the adjusted teacher rating of attentiveness for student i in class j, R_{ij} is the teacher rating of student attentiveness, $\overline{R}_j$ is the class mean of the teacher ratings of student attentiveness for class j, and $\overline{E}_j$ is the mean class engagement estimate for class j. This procedure prevents Y_{ij} from being negative, and preserves the relative ranking of students within class.

Sample

The field work carried out by Far West Laboratory during the continuation year of Phase III-A of the Beginning Teacher Evaluation Study (see Far West Laboratory, 1975) involved a sample of 33 teachers. This sample was composed of 16 Grade 5 and 17 Grade 2 teachers. Each volunteered to participate in the one-year study.

The teachers were recruited in the San Francisco Bay Area by Far West Laboratory staff during the spring of 1975. After meetings with administrative officials and building principals in ten districts, individual teachers were contacted. The study was described, and teachers were offered extension credits (through a cooperating college) or an honorarium in return for their participation.

In September of 1975, it was decided to conduct the reading and mathematics studies with separate samples of teachers. The teachers at both grade levels chose to participate in either the reading or the mathematics sample.

The study being reported concentrated on the Grade 2 reading subsample, which consisted of nine teachers. Given practical and financial constraints, it was not possible to carry out extensive direct observation in all classes. As a result, six of the Grade 2 reading classes were selected for direct observation. Selection for the observation subsample was made on the basis of variety of instructional organization across classes and representation of inner city, suburban, and mixed populations. All of the teachers selected agreed to be included in the observation subsample. Since the direct observation required observers to be present for the entire school day, it was feasible to collect information on both reading and mathematics instruction. As a result, this subsample was treated as a regular part of the Grade 2 reading sample; but, in addition, several mathematics scales were administered to the classes, and teachers kept logs of both reading and mathematics instruction. This report deals only with the mathematics data collected from the six teachers in the observation subsample.

Teachers in this subsample completed a remarkable amount of work in connection with the study. (The work reported here is based on data collected over approximately 10 weeks of instruction during the fall of 1975; the teachers continued to contribute to other facets of the Beginning Teacher Evaluation Study through the spring of 1976.) Each teacher received either a $50 honorarium or four extension credits for participating in the study. They were paid $10 per week for the completion of teacher logs (kept over a period of approximately 12 weeks). Teachers who were observed for a two-week period were given an additional honorarium of $100.

The six classes represented a variety of background characteristics. Two classes served a relatively lower class inner-city population, two served a mixed population, and two served middle class suburban areas. No two classes were in the same school, and the schools represented four different school districts in the San Francisco Bay area. The mathematics curricula in the classes varied considerably; but to some degree, all used the State of California mathematics series for Grade 2. The teachers were all female, with several years experience in teaching. One of the teachers had no prior second-grade teaching experience, although she had had experience at other elementary school grade levels.

Several of the classes were split grades, containing some Grade 1 students and some Grade 2 students. Only Grade 2 students (but not necessarily all Grade 2 students in a given class) were included in the study. Of the Grade 2 students in a class, teachers were asked to nominate those who were reading at a level below the middle of Grade 1. Since the low reading level would have made it difficult to test these students reliably, they were not tested, nor were they followed via the log procedure. At the initial testing, it became clear that several other students were not able to complete the tests. These students were also dropped from the study. This left approximately 120 students in 6 classes as the student sample available for analysis.

III THE COLLECTION AND ANALYSIS OF DATA

Data Collection

The data collected for the six Grade 2 classes are summarized schematically in Table 3.1. Except for the use of the teacher ratings of attentiveness and the mean class engagement estimates, this report deals only with the mathematics data. The eight-week test data were comprised of the scores obtained from testing occasions A (first week of October) and B (first week of December). The teacher log data describe the mathematics instruction for the A-B intertest period. The two-week test data were comprised of scores obtained on testing occasions OA and OB. For Classes 1 and 3, this period fell in the latter half of October. For the remaining two pairs of classes, (numbers 4 and 5 and numbers 2 and 6), the OA-OB interval came during the first and last two weeks of November respectively. The direct observation data and observer log data describe mathematics instruction during the OA-OB interval.

At occasions A and B, the mathematics tests were administered in a group situation over a 30-minute period. They were administered by Far West Laboratory staff, but not by the observers. No other tests were given on the same day. At the OA and OB occasions, both mathematics and reading tests were administered in one 45-minute session. This testing was administered by the observers. All test administrators were briefed on the testing procedure, and approximately half of the testers administered at least one of the tests in a classroom practice session before testing began. Those test administrators who did not have a practice administration acted as observers at least once while a test was being administered to a class. The guidelines for test administration are

Table 3.1

Summary of Data Collected on Six Grade 2 Classes

Class	2 week observation data	2 week test scores	8 week log data	8 week test scores	8 week attitude data	2 week observer logs	1 day coder logs	1 day coder estimate of mean class engagement	teacher ratings of student attentiveness
1	R,M	R,M	R,M	R,M	R,M	R,M	R	R	R
2	R,M	R,M	R,M	R,M	R,M	R,M	R	R	R
3	R,M	R,M	R,M	R,M	R,M	R,M	R	R	R
4	R,M	R,M	R,M	R,M	R,M	R,M	R	R	R
5	R,M	R,M	R,M	R,M	R,M	R,M	R	R	R
6	R,M	R,M	R,M	R,M	R,M	R,M	R	R	R

Note: In this table R represents reading data and M represents mathematics data.

included in Appendix A. Test administrators completed testing report forms (see Appendix A) after every administration, and were debriefed after testing occasions A and B.

The testing conditions were, on the whole, reasonably good. There were, however, the usual number of unexpected interruptions. At the A testing occasion, the tests proved difficult for many students and, caused frustration for some. Items with unfamiliar terminology or symbols which could have caused reading difficulties were read to the students by the test administrator. Care was taken to have the teachers present in the classroom, to conduct the testing sessions at the same time of day, and to adhere to time limits developed during pilot testing. These precautions (and many others listed in the training materials) were intended to reduce measurement error; however, the difficulty of conducting field testing over several occasions (even in a small number of classes) is not to be underestimated.

Student responses were made directly on the test booklets. The completed booklets were returned to the Far West Laboratory for processing. Some hand-scoring was required, after which the item responses were punched on cards and verified. Scoring was done by a computer routine, and the standard correction for guessing was applied. Item analyses were conducted, and internal consistency reliability coefficients calculated.

Data collection for the teacher logs began early in September with one-to-one meetings with each participant. Materials on log-keeping were explained, and teachers began to keep practice logs up to two weeks before the A testing occasion. Each teacher was visited several times so that any questions about log keeping could be answered. The amount of feedback

which teachers required varied considerably. The more complex the organization for instruction was, the more complicated the log-keeping became.

Once the class rosters were finalized and teachers had some practice, the log-keeping seemed to go smoothly. Teachers were asked to complete their logs each day, and to return them to the Far West Laboratory by mail every Friday. This procedure worked quite well, although teachers were sometimes late in returning logs, and it is not certain that all teachers completed them every day.

When logs were returned to the Far West Laboratory, they were visually checked and given to a coder who transferred the information onto standard IBM coding sheets. The log for any given day was coded as a series of events, where each event was defined by a content code, the setting codes, and the time allocated to that event. Events were associated with particular students, so that a student's mathematics instruction for the day appeared as a series of events. All of the logs were punched by student by day. Given that a student typically had four or five events per day, and that the sample of approximately 120 students was tracked by logs for approximately 40 days, the management of the log data was a challenging task.

Once all of the logs were coded and punched, two types of validity checks were carried out. First, the number of days represented for each student was checked to make sure that all the days in the A-B interval were accounted for. This task was done by hand, using the raw logs and absentee information to edit any discrepancies. In addition, for one student in each class, the number of events on the computer printout was handchecked against the raw logs. This was done to insure that students

had the correct number of events. Besides the handchecking procedures, range tests were made by the computer.

When the log data had been checked and cleaned in this manner, allocated times were accumulated over days. This generated a vector of times (in minutes) for each student representing the distribution of allocated mathematics time for that student in the categories formed by all possible content-by-setting combinations. For mathematics, there were a total of 216 categories (8 setting combinations by 27 specific content categories). At this stage there were 112 students with complete log data. Therefore, the fundamental log data matrix was 112 rows by 216 columns, where the entries were total allocated time in mathematics for the A-B testing interval. By aggregating over columns of this matrix, it was possible to generate allocated time by settings, allocated time by general content categories, etc. The time data used in the A-B analyses of instructional time and student achievement were based on this matrix.

The accuracy of the teacher logs was investigated by comparing data from teacher and observer logs. A second aggregation of the teacher log data (over the days in the OA-OB interval) was made for this purpose.

The observer logs were processed in a manner similar to the teacher logs. In this case, the mathematics instruction was coded by general content categories only, thus making the fundamental matrix for observer logs 112 rows by 80 columns (8 setting combinations by 10 general content categories). The allocated times in this matrix represented instruction over a seven-day period within the OA-OB interval.

Data collection for the direct observation procedure began with arrangements with the teacher for a two week period for observation. At this time, the observer obtained an outline of classroom routine and discussed the nature of the observation with the teacher. It was made clear to the teacher that information on engaged time in instruction for individual students would be collected, and that no data on teacher behavior were being recorded. The OA and OB testing was discussed, and teachers were told what scales would be administered. In addition, teachers were asked to spend time on instruction in place value. This request was intended to ensure that all students would have at least some time in a common content category. It was desirable to have significant amounts of engaged time in one or more time categories; otherwise it would be difficult to demonstrate growth in achie over a two-week period.

On the first observation day, the observer memorized the names of students who were to be observed, and became familiar with classroom routine. During this day, the observation procedure was practiced in this new setting, and teacher and students had time to become accustomed to the observer. Every day during the observation period, the observer entered the class with or before the students and remained for the entire school day. This allowed the coding of all instruction relevant to mathematics (and reading). On the second day of the observation period, the OA testing was administered by the observer. Immediately after the testing, observation data collection began and continued during in-school hours until the OB testing date.

During the post-reliability check for the observation procedure, several errors in transferring times from raw observation coding forms to standard coding booklets were discovered. The post-reliability data were completely checked and any errors corrected. This situation raised questions about the transfer process for the study data. As a result, a random sample of the study data was recoded. For each teacher, two days were randomly selected from the set of observation days. The corresponding raw observation data were recoded. This was done for both the reading and mathematics data; 26 of the 104 booklets (representing 25 percent of the data) were recoded. In this sample, 76 errors were found in a total of 1746 entries. This corresponded to a 4 percent error rate. The errors varied in size. When all errors were combined, the total number of minutes (regardless of sign) was 365.6. The average error had a magnitude of 4.8 minutes. The errors discovered in this sample were corrected before further processing of the observation data. Given that some of the errors would "cancel out," that the errors were distributed over a relatively large number of students, and that the average error was small, transfer and coding errors in the observation data were of minor importance.

The observed engaged times were aggregated over days, generating a 112-row by 48-column matrix (6 observation content categories by 8 setting combinations). These data were aggregated twice; once over all days between the OA and OB testing, and once over the OA-OB period minus the days on which the testing actually took place. The latter aggregation was used for comparison with the observer logs and the subset of the teacher logs which had been aggregated over the identical days.

Analysis

The results presented in the next chapter are divided into three sections: characteristics of teacher log data, description of time allocated to mathematics content- and setting-categories, and analysis of instructional time and mathematics achievement. This section summarizes the procedures used in arriving at those results.

The data on teacher log characteristics are presented descriptively. Each class was treated separately and within-class correlations are presented between teacher log times and observer log times. No significance testing has been carried out on these data.

The time-allocation data are presented in summary form. In the main, class means and standard deviations are shown. No statistical comparisons have been made on these data.

The section on time and learning was more problematic. The objective of analyses in this section was to show whether or not students who spend more time in a particular content area also show higher levels of achievement in that content area. The analyses undertaken assumed that posttest achievement level was a function of pretest achievement level, general aptitude for school learning and the amount of instructional time spent on the subject area. Multiple regression analysis was selected as the procedure for analyzing the data. In this analytical framework, the questions of major interest became "Is the raw regression weight for time positive?" and "Is that weight bounded away from zero?" (A positive regression weight indicates that more time is associated with more learning. However, weights are of relatively little interest, if a typical confidence band around the regression weight includes zero.)

One way to proceed would have been to conduct analyses within each class, since the other instructional conditions for members of the same class were reasonably homogeneous. In the current data set, this would have required running analyses on very small samples ranging in size from 14 to 26. Such analyses could hardly be expected to yield stable results.

The procedure used instead required two separate steps. First, all subjects were pooled regardless of class membership, and multiple regression analyses were conducted. A substantial positive regression weight for time was interpreted as meaning "more time/more learning," but the source of the effect was somewhat ambiguous. It could have resulted from differences among classes (but no differences among students within the same class), differences among students within the same class (but no differences among classes), or both. At this point, class means were plotted to help clarify the ambiguity. If no effect for time was found, a within-class relationship remained possible.

Regardless of the results of this first step, a second step was carried out. Scores on each variable were transformed to deviations from their respective class means, and the regression analyses were rerun on the deviation scores. This procedure is described by Cronbach and Webb (1975).

A substantial positive regression weight for time on the second step was interpreted as follows. Students with more time have higher levels of achievement regardless of class mean differences. No effects on both steps would indicate that, for this sample and for this model specification, instructional time was not linearly related to achievement.

Analyses carried out in the first step of this procedure are referred to as "analyses with subjects pooled." Those carried out in the second step are referred to as "analyses with subjects pooled within class."

Specifying which variables to include in the regression model was somewhat difficult. In each case, academic status was used as a measure of aptitude. The time variable was defined as the time in the content category which matched the content assessed by the achievement test. In some cases, additional analyses are presented where either additional or different time variables were entered into the model. As a general rule, analyses of achievement over the OA-OB period include engaged time measures from direct observation. Analyses of achievement over the A-B period have been carried out twice: once using allocated time estimates from the teacher logs, and once using adjusted allocated time obtained by multiplying the allocated time from the teacher logs by the observed engagement rate. Throughout this report, this adjusted time is referred to as "estimated engaged time (from teacher logs)."

Each regression run was made on cases with complete data. Although the mathematics tests were quite difficult, there were small ceiling effects. To reduce these effects, the pretest score distribution was examined and several cases trimmed, so that each student had the opportunity to gain at least as many score units as were gained by the sample as a whole. Moderate trimming (to provide complete data and reduce ceiling effects) was carried out as a routine procedure. In some cases, an analysis was repeated after a more radical trim. ("Radical trimming" here means that one or more classes were omitted from the analysis.

Classes were omitted for several reasons. The cases of radical trimming are noted and explained where they occur.)

IV RESULTS

Results are presented in three general areas: characteristics of teachers' allocated time logs, allocations of instructional time to mathematics, and relations between instructional time and student achievement. Time variables are reported in minutes unless otherwise noted. Achievement scores are reported in raw score units where, in each case, the scores have been corrected for guessing.

An overview of time allocated to mathematics is presented in Table 4.1. Some comments on this table may clarify the conditions under which data were gathered and facilitate the understanding of later tables. Note that class size averaged 28 students, and that in most classes only a portion of the total class was included in the Beginning Teacher Evaluation Study data collection. Data were available for a total of 112 students in the six Grade 2 classes. With very few exceptions, results included in this report were based on analysis of all or some of this group of 112 students.

The number of days of instruction in the A-B testing interval ranged from a high of 40 days to a low of 34 days (see Table 4.1). This variation did not affect the time-and-learning analysis, since all relevant in-school time between pre- and posttest was accounted for. However, the discrepancy does cloud between class comparison of allocated time. This problem could have been avoided by the reporting of time per day or time per student-day; but this would give the impression that time was allocated to every sub-content area on a daily basis, which was not true. Therefore, in the time-allocation section of this chapter, times are reported for a 40-day instructional period; and for classes where

Table 4.1

Class size, length of school day, adult instructional time and time allocated to mathematics for six grade 2 classes

class	total class size	number of students included in BTES	number of days instruction in A-B interval	length of school day for students (minutes)	number of paid aides	instruction time provided by aides (mins./day)	total adult instruction time (mins./day)	average mins. per student per day allocated to math instr.	proportion of school day allocated to math instruction
1	30	16	40	255	1	435	180	35.6 (5.1)[a]	.14
2	28	18	37	240	0	300	0	47.6 (2.5)	.20
3	29	20	37	250	2	580	330	48.8 (4.4)	.20
4	30	14	34	235	1	395	160	26.1 (3.3)	.11
5	26	26	37	250	1	530	240	37.8 (3.6)	.15
6	27	18	38	255	1	405	150	24.1 (1.8)	.09
Average of class values (unweighted)	28	19	37	248	1	424	177	36.7	.15

[a]-Values in parentheses are standard deviations computed within each class.

the actual A-B interval was less than 40 days, times have been adjusted proportionately. All of the allocated time information was taken from the teacher logs kept over the A-B period.

The length of the school day for a student varied by as much as 20 minutes depending upon which class he attended. The times recorded are in-class times, minus times for lunch and recesses. Since some classes operated on a staggered-day routine, where part of the class came early and went home early while a second group came and went home late, the length-of-school-day figures do not necessarily reflect the amount of student contact-time for teachers. (Class 2 clearly illustrates the effect of the staggered day. Note that a student in Class 2 spent 240 minutes in daily instruction, but that the teacher instructed students for 300 minutes per day.) The total amount of adult instructional time reported in Table 4.1 was calculated by summing the in-class time for all paid adults in the classroom. The preceding column indicates how much of this adult instructional time was contributed by paid aides. The algebraic difference between the two adult time columns equals the instructional time spent by the classroom teacher. Although the adult time figures were difficult to interpret for any particular student, at the class level it was clear that quite different amounts of adult instructional time were allocated to different classes. Within this small sample, Class 3 reported 77 percent more allocated adult time than did Class 2. The figures in the table do not account for adult instructional time which may have been provided by volunteers, nor has any non-instructional support time been considered.

The average number of minutes allocated to mathematics instruction per student per day was calculated by summing all allocated time in mathematics

over the A-B period and subsequently computing the average over days and students within each class. From Table 4.1, the average amount of time allocated to mathematics varied by as much as a factor of 2 from one class to another. Note also that there was some variation in time allocated to mathematics within a particular class, and that this variability changed from class to class. The variability within class represents differential student absence rates as well as differential allocation patterns across students within a class.

Since the within-class standard deviations were quite small, it appears that the amount of time allocated to mathematics for a particular child was determined by his class membership; and that (allowing for absenteeism) students in the same class were allocated approximately the same amount of time in mathematics. The final column in Table 4.1 reports the mean allocated time in mathematics per student per day as a proportion of the total instruction per school day.

Characteristics of Teacher Allocated Time Logs

The teacher logs provided measures of allocated time over the A-B period. At a practical level, the procedure proved workable. Teachers were able to use the content and setting categories, and to keep records of time allocated to various kinds of instruction. The procedure was also flexible enough to allow data collection in very different classroom organizational structures. Comparison of the teacher logs with observer logs provided information on the accuracy of the recorded allocated times. The observer logs had been completed at the end of each school day during the OA-OB period. (This task was a secondary priority for the observers, since all of their in-school time was taken up with direct observation; and after school hours, their primary task was the transference of direct observation data from the observation coding form to the standard coding booklets.)

The allocated time logs completed by the observers differed from the teacher logs in at least two important ways. First, observer allocated time logs recorded content at the level of general content categories, while the teachers' logs used specific content categories. This mismatch prevented the comparison of allocated time within all of the specific content categories, but did allow comparison of allocated time within the general content categories.

Second, the observer logs were coded for content using a strategy referred to as "focus coding." This requires that an instructional activity be placed in one particular content category, if possible -- the most complex category which describes the activity. (Multiplication would be coded as "multiplication," and not as part multiplication and part addition, even though addition is part of the multiplication process.) When contents were covered in sequence, each was coded with its appropriate allocated time, but where contents were coextensive in time, the more complex content was coded. This focusing on one content category was used in direct observation and hence carried over into the coding of the observer allocated time logs.

The teacher logs, on the other hand, used a strategy referred to as "multiple coding" for categorizing content. In this procedure, teachers are encouraged to use more than one content code, if it improves the description of the activity. In processing the logs, if an instructional activity received more than one content code for a time interval, the time was distributed equally over the content codes. The same activity can be coded quite differently, depending upon whether focus coding or multiple coding is used.

In spite of these differences, the observer logs were the best source of information for checking the accuracy of teacher allocated time logs. Tables 4.2 through 4.7 present comparative data on observer and teacher logs. Each table presents information on one teacher. The tables are identical in format. These tables deal only with the content information and, for the moment, ignore the setting information in the log data. Since the last part of this chapter presents time and learning results, the content characteristics of the logs were given first priority.

The tables are based on teacher logs, observer logs, and direct observation information for days when all three sources were available for a given class. Table 4.7, describing the log characteristics for Class 6, is based on data from six days of instruction. The tables for the other five classes are each based on information from seven days of instruction.

The rows of each table are labeled by general content category. The first 10 rows represent the 10 general content categories, row eleven is a subtotal for general content categories 6 through 10, and row twelve shows total time in mathematics instruction (the sum over general content categories 1 through 10). The entries in column A are allocated times from the teacher logs. Column C presents allocated time from the observer logs. Information in all general content categories was included for columns A and C, since the logs provided this information. Columns A and C provide the basic comparison for allocated time. Column D presents engaged time from direct observation. Since the direct observation system used one content category to cover general content categories 6 through 10, some rows in column D are blank. Direct observation data were available

...over seven days of instruction for which all three sources of time information were available. (N = 16)

CLASS 1

	General Content Category	A Allocated Time From Teacher Logs	B Adjusted Allocated Time (From Teacher Logs)	C Allocated Time From Observer Logs	D Engaged Time From Direct Observation	r_{AC}	r_{AD}	r_{BD}	Average Difference[a] for columns A and C	Average Difference[b] for columns B and D
1	Addition No Regrouping	55 (11)	24 (7)	51 (4)	26 (9)	-.22	-.67	-.18	6 (11)	10 (7)
2	Addition With Regrouping	0 (0)	0 (0)	0 (0)	1 (1)	--[c]	.00	.00	0 (0)	1 (1)
3	Subtraction No Regrouping	53 (11)	23 (7)	32 (2)	18 (7)	.33	-.62	-.25	21 (10)	9 (8)
4	Subtraction With Regrouping	0 (0)	0 (0)	0 (0)	0 (0)	--	--	--	0 (0)	0 (0)
5	Place Value	0 (0)	0 (0)	30 (0)	23 (10)	--	.00	.00	30 (0)	23 (10)
6	Number System	44 (2)		9 (3)		-.10			35 (3)	
7	Measurement	0 (0)		0 (0)		--			0 (0)	
8	Geometry	0 (0)		0 (0)		--			0 (0)	
9	Word Problems	41 (2)		21 (3)		.59			21 (3)	
10	Other	0 (0)		84 (17)		.00			84 (17)	
	Categories 6 through 10 Combined	86 (4)	38 (12)	114 (19)	37 (7)	.98	.62	.25	31 (9)	10 (7)
	Total Mathematics Categories 1 Through 10 Combined	194 (23)	84 (26)	227 (23)	104 (16)	.35	-.54	-.25	39 (17)	31 (23)

[a] The entries in this column are average differences without regard for sign between allocated time from teacher logs and allocated time from observer logs.

[b] The entries in this column are average differences without regard for sign between adjusted allocated time (from teacher logs) and engaged time from direct observation.

[c] A -- indicates perfect agreement between sources of time information but there was no variance on either variable.

Means, standard deviations, correlations and average differences for Class 2 on allocated time from teacher logs, adjusted allocated time from teacher logs, allocated time from observer logs, and engaged time from direct observation. These data are summed over seven days of instruction for which all three sources of time information were available. (N = 18)

CLASS 2

General Content Category	A Allocated Time From Teacher Logs	B Adjusted Allocated Time (From Teacher Logs)	C Allocated Time From Observer Logs	D Engaged Time From Direct Observation	r_{AC}	r_{AD}	r_{BD}	Average Difference[a] for columns A and C	Average Difference[b] for columns B and D
1 Addition No Regrouping	51 (12)	25 (6)	0 (0)	6 (8)	.00	.29	.11	51 (12)	20 (8)
2 Addition With Regrouping	0 (0)	0 (0)	0 (0)	0 (0)	--[c]	--	--	0 (0)	0 (0)
3 Subtraction No Regrouping	55 (15)	27 (8)	5 (1)	7 (4)	-.01	.59	.51	51 (15)	20 (6)
4 Subtraction With Regrouping	0 (0)	0 (0)	0 (0)	0 (0)	--	--	--	0 (0)	0 (0)
5 Place Value	101 (24)	49 (12)	209 (47)	176 (45)	.79	.81	.75	109 (32)	127 (37)
6 Number System	42 (9)		38 (17)		.66			7 (12)	
7 Measurement	0 (0)		0 (0)		--			0 (0)	
8 Geometry	0 (0)		0 (0)		--			0 (0)	
9 Word Problems	0 (0)		0 (0)		--			0 (0)	
10 Other	0 (0)		0 (0)		--			0 (0)	
Categories 6 through 10 Combined	42 (9)	21 (5)	38 (17)	0 (0)	.66	.00	.00	7 (12)	21 (5)
Total Mathematics Categories 1 Through 10 Combined	249 (49)	121 (27)	252 (55)	189 (51)	.84	.85	.70	24 (18)	68 (37)

[a] The entries in this column are average differences without regard for sign between allocated time from teacher logs and allocated time from observer logs.

[b] The entries in this column are average differences without regard for sign between adjusted allocated time (from teacher logs) and engaged time from direct observation.

[c] -- indicates perfect agreement between sources of time information but there was no variance on either variable.

allocated time from teacher logs, allocated time from observer logs, and engaged time from direct observation. These data are summed over seven days of instruction for which all three sources of time information were available. (N = 20)

CLASS 3

General Content Category	A Allocated Time From Teacher Logs	B Adjusted Allocated Time (From Teacher Logs)	C Allocated Time From Observer Logs	D Engaged Time From Direct Observation	r_{AC}	r_{AD}	r_{BD}	Average Difference[a] for columns A and C	Average Difference[b] for columns B and D
1 Addition No Regrouping	64 (7)	16 (5)	51 (4)	23 (8)	.88	.14	-.42	13 (4)	10 (8)
2 Addition With Regrouping	0 (0)	0 (0)	0 (0)	0 (0)	--[c]	--	--	0 (0)	0 (0)
3 Subtraction No Regrouping	71 (13)	17 (6)	70 (16)	44 (13)	.86	.65	.51	4 (7)	26 (11)
4 Subtraction With Regrouping	0 (0)	0 (0)	0 (0)	1 (3)	--	.00	.00	0 (0)	1 (3)
5 Place Value	157 (12)	39 (11)	133 (20)	47 (10)	.54	.27	.68	24 (17)	9 (8)
6 Number System	54 (23)		0 (0)		.00			54 (23)	
7 Measurement	0 (0)		0 (0)		--			0 (0)	
8 Geometry	0 (0)		0 (0)		--			0 (0)	
9 Word Problems	29 (7)		19 (4)		1.00			10 (2)	
10 Other	0 (0)		0 (0)		--			0 (0)	
Categories 6 through 10 Combined	83 (23)	21 (9)	19 (4)	5 (7)	.18	.44	.46	64 (23)	16 (8)
Total Mathematics Categories 1 Through 10 Combined	374 (42)	93 (28)	273 (31)	120 (22)	.92	.54	.45	101 (18)	32 (21)

[a] The entries in this column are average differences without regard for sign between allocated time from teacher logs and allocated time from observer logs.

[b] The entries in this column are average differences without regard for sign between adjusted allocated time (from teacher logs) and engaged time from direct observation.

[c] A -- indicates perfect agreement between sources of time information but there was no variance on either variable.

...correlations, correlations and average differences for class 4 on allocated time from teacher logs, adjusted allocated time from teacher logs, allocated time from observer logs, and engaged time from direct observation. These data are summed over seven days of instruction for which all three sources of time information were available. (N = 14)

CLASS 4

General Content Category	A Allocated Time From Teacher Logs	B Adjusted Allocated Time (From Teacher Logs)	C Allocated Time From Observer Logs	D Engaged Time From Direct Observation	r_{AC}	r_{AD}	r_{BD}	Average Difference[a] for columns A and C	Average Difference[b] for columns B and D
1 Addition No Regrouping	39 (21)	24 (14)	68 (21)	90 (30)	.63	.43	.38	31 (12)	66 (28)
2 Addition With Regrouping	6 (2)	3 (1)	14 (0)	0 (0)	.00	.00	.00	8 (2)	3 (1)
3 Subtraction No Regrouping	15 (10)	9 (6)	52 (26)	1 (0)	.41	.00	.00	38 (21)	8 (6)
4 Subtraction With Regrouping	0 (0)	0 (0)	0 (0)	0 (0)	--[c]	--	--	0 (0)	0 (0)
5 Place Value	19 (12)	12 (8)	16 (9)	18 (12)	-.17	.10	.05	13 (8)	12 (8)
6 Number System	40 (23)		53 (33)		.11			31 (24)	
7 Measurement	0 (0)		0 (0)		--			0 (0)	
8 Geometry	25 (15)		0 (0)		.00			25 (15)	
9 Word Problems	0 (0)		0 (0)		--			0 (0)	
10 Other	0 (0)		0 (0)		--			0 (0)	
Categories 6 through 10 Combined	65 (34)	40 (22)	53 (33)	1 (6)	.11	.13	.14	37 (25)	39 (22)
Total Mathematics Categories 1 Through 10 Combined	145 (65)	88 (47)	202 (43)	110 (35)	.26	.51	.43	72 (50)	42 (24)

[a] The entries in this column are average differences without regard for sign between allocated time from teacher logs and allocated time from observer logs.

[b] The entries in this column are average differences without regard for sign between adjusted allocated time (from teacher logs) and engaged time from direct observation.

[c] A -- indicates perfect agreement between sources of time information but there was no variance on either variable.

Means, standard deviations, correlations and average differences for class 5 on allocated time from teacher logs, adjusted allocated time from teacher logs, allocated time from observer logs, and engaged time from direct observation. These data are summed over seven days of instruction for which all three sources of time information were available. (N = 26)

CLASS 5

General Content Category	A Allocated Time From Teacher Logs	B Adjusted Allocated Time (From Teacher Logs)	C Allocated Time From Observer Logs	D Engaged Time From Direct Observation	r_{AC}	r_{AD}	r_{BD}	Average Difference[a] for columns A and C	Average Difference[b] for columns B and D
1 Addition No Regrouping	103 (14)	41 (10)	220 (29)	76 (24)	.96	.64	-.01	118 (15)	35 (26)
2 Addition With Regrouping	0 (0)	0 (0)	5 (1)	3 (1)	.00	.00	.00	5 (1)	3 (1)
3 Subtraction No Regrouping	92 (21)	37 (12)	148 (29)	65 (23)	.84	.57	.17	57 (16)	29 (23)
4 Subtraction With Regrouping	0 (0)	0 (0)	0 (0)	0 (0)	--[c]	--	--	0 (0)	0 (0)
5 Place Value	14 (5)	6 (3)	44 (6)	13 (7)	.81	.48	.51	31 (3)	7 (6)
6 Number System	38 (15)		31 (13)		.95			8 (5)	
7 Measurement	0 (0)		0 (0)		--			0 (0)	
8 Geometry	0 (0)		0 (0)		--			0 (0)	
9 Word Problems	8 (7)		0 (0)		.00			8 (7)	
10 Other	0 (0)		0 (0)		--			0 (0)	
Categories 6 through 10 Combined	46 (10)	19 (8)	31 (13)	9 (7)	.93	.83	.76	15 (5)	10 (5)
Total Mathematics Categories 1 Through 10 Combined	254 (37)	104 (31)	448 (59)	166 (43)	.93	.59	.09	195 (28)	63 (49)

[a] The entries in this column are average differences without regard for sign between allocated time from teacher logs and allocated time from observer logs.

[b] The entries in this column are average differences without regard for sign between adjusted allocated time (from teacher logs) and engaged time from direct observation.

[c] a -- indicates perfect agreement between sources of time information but there was no variance on either variable.

allocated time from teacher logs, allocated time from observer logs, and engaged time from direct observation. These data are summed over six days of instruction for which all three sources of time information were available. (N = 18)

CLASS 6

General Content Category	A Allocated Time From Teacher Logs	B Adjusted Allocated Time (From Teacher Logs)	C Allocated Time From Observer Logs	D Engaged Time From Direct Observation	r_{AC}	r_{AD}	r_{BD}	Average Difference[a] for columns A and C	Average Difference[b] for columns B and D
1 Addition No Regrouping	22 (22)	9 (9)	78 (26)	44 (21)	.63	.60	.62	56 (20)	35 (17)
2 Addition With Regrouping	4 (5)	2 (3)	0 (0)	0 (0)	.00	.00	.00	4 (5)	2 (3)
3 Subtraction No Regrouping	19 (23)	7 (9)	68 (21)	32 (13)	.56	.53	.53	50 (19)	25 (11)
4 Subtraction With Regrouping	0 (0)	0 (0)	0 (0)	0 (0)	--[c]	--	--	0 (0)	0 (0)
5 Place Value	0 (0)	0 (0)	0 (0)	0 (0)	--	--	--	0 (0)	0 (0)
6 Number System	0 (0)		86 (24)		.00			86 (24)	
7 Measurement	43 (27)		0 (0)		.00			43 (27)	
8 Geometry	22 (29)		0 (0)		.00			22 (29)	
9 Word Problems	30 (28)		0 (0)		.00			30 (28)	
10 Other	0 (0)		0 (0)		--			0 (0)	
Categories 6 through 10 Combined	94 (54)	53 (35)	86 (24)	41 (18)	.85	.92	.80	31 (18)	21 (16)
Total Mathematics Categories 1 Through 10 Combined	139 (23)	72 (28)	232 (52)	117 (33)	.78	.75	.36	92 (37)	45 (35)

[a] The entries in this column are average differences without regard for sign between allocated time from teacher logs and allocated time from observer logs.

[b] The entries in this column are average differences without regard for sign between adjusted allocated time (from teacher logs) and engaged time from direct observation.

[c] A -- indicates perfect agreement between sources of time information but there was no variance on either variable.

for only the first five general content categories and the sum of general content categories 6 through 10. Allocated times from the teacher logs were multiplied by the adjusted teacher ratings of student attentiveness. This product, referred to as "adjusted allocated time (from teacher logs)" is presented in the tables as column B.

The purpose of calculating the adjusted allocated time was to allow comparison with the engaged time from direct observation. Therefore, column B presents data in only those rows (general content categories) for which engaged time from direct observation was available. Columns B and D then allow a comparison of measures of adjusted allocated and engaged time from independent sources. In addition to comparison of means and standard deviations, three sets of Pearson product-moment correlation coefficients were calculated. The first, r_{AC}, describes the relation between the two sources of allocated time. The second, r_{AD}, describes the relation between allocated time from teacher logs and engaged time from direct observation. Finally, r_{BD}, represents the degree of relationship between adjusted allocated time and engaged time. The final columns in the tables provide average differences (without regard for algebraic sign) between columns A and C, and B and D respectively. These average differences give an idea of the discrepancy between the various time measures. No further comment will be made on these last two columns since, in the main, they were almost identical to the difference between the means for their respective columns. This implied that the differences within a general content category were almost always of the same sign.

A simple summary of Tables 4.2 through 4.7 is difficult but several comparisons do shed some light, for example, the comparison of allocated time from teacher logs and from observer logs. The means in columns A

and C for rows 1 through 11 did not agree consistently; for some rows they seemed to agree quite well while for others they did not. No class had agreement in all rows, but there were several content categories where all classes agreed. In the main, these were categories where no time had been allocated (general content categories 2, 4, 7 and 10). Of the 66 average differences in columns A and C (6 classes by rows 1 through 11), 39 were less than 15 minutes in magnitude. However, among the remaining average differences, there were a number of high values. These 66 mean differences were based on comparisons within general content categories (or, in the case of row 11, a subset of general content categories). These comparisons reflect a number of sources of error. One was the use of the different coding strategies for the two data sources. (Teacher logs were coded using the multiple coding strategy, while the observer logs used focus coding.) Amount of error due to coding strategy differences as compared to other sources of error is unknown. Class 2 (Table 4.3) demonstrates this difficulty clearly. Note that, in this table, the means in columns A and C match remarkably well, with the exception of general content categories 1, 3 and 5. However, note too that the sum of general content categories 1, 3 and 5 for column A (207 minutes) is almost identical with the corresponding sum for column C (214 minutes). In this case, the observer log (which used focus coding) allocated practically all of the time in question to place value, while the teacher log (using multiple coding) divided the time (half going to place value and one quarter each to addition and subtraction without regrouping).

The variance in time allocated to mathematics was relatively low within class; that is, students in the same class tended to get the same

amount of time allocated to mathematics. This caused the content categories to function as a partially ipsative set -- the amount of time in any one category was not independent of the time in the other categories. Furthermore, an error in one category tended to cause errors in one or more additional categories.

For total times allocated to mathematics, relatively large differences between sources of data were found. Note that when allocated time was summed over content categories, coding strategy differences no longer had an effect. The correlations between columns A and C were moderately high, where the data allowed the coefficients to be calculated. The major exceptions to this observation occurred in Classes 1 and 4.

The correlation between the two sources of allocated time data accumulated over general content categories provided a reasonable summary description for the classes. Within four of the classes (2, 3, 5, and 6), the students were ranked similarly on amount of allocated time from the teacher logs and from the observer logs. The correlations for these classes were 0.84, 0.92, 0.93, and 0.78 respectively. For Classes 1 and 4, the correlations were 0.35 and 0.26 respectively.

Upon examination of the correlations between allocated time from teacher logs and engaged time from direct observation, several interesting findings emerged. First, for Classes 1 and 4 (which had poor overall agreement between the two sources of allocated time), the values of r_{AD} were -0.54 and 0.51 respectively. For the four classes where the two sources of total allocated time agreed reasonably well within class, r_{AD} was approximately equal to r_{AC} for two classes (2 and 6), and was substantially lower than r_{AC} for the others (Classes 3 and 5).

Turning now to the comparison of adjusted allocated time from teacher logs and engaged time from direct observation: the differences in the means in columns B and D followed a pattern similar to that described for columns A and C. In this case, 23 of 36 comparisons within general content categories showed means differing by less than 15 minutes. Agreement across classes was good for general categories 2, 4 and 5. An important question was whether the allocated time from teacher logs or the adjusted allocated time from the teacher logs was more highly correlated with the engaged time from direct observation. A comparison of r_{AD} and r_{BD} shows that, in all classes, the allocated time from teacher logs was more highly correlated with engaged time from direct observation. For Classes 5 and 6, the differences between r_{AD} and r_{BD} were substantial. So, in this sample, the characteristics of the allocated time from teacher logs were not improved by the adjustment procedure. (Since the teacher ratings were unsuccessful, no analyses of instructional time and achievement were conducted using them. Although this particular adjustment was not useful, there are many others which could prove to be very useful.)

Allocation of Instructional Time in Mathematics

The data on allocated time from the teacher logs, accumulated over the A-B interval (approximately 8 weeks), provide a summary record of how time was spent during mathematics instruction in the six Grade 2 classes. (The log data were far from being error free and, as a result, small differences in allocated times do not warrant interpretation.)

Table 4.8 illustrates how mean time allocated to mathematics (as reported in the teacher logs) was distributed by content subarea for the A-B testing interval. The general content categories make up the columns of this table.

Table 4.8

Means and standard deviations for time allocated to general content categories in mathematics for six grade 2 classes. The entries are class averages reported in minutes per student accumulated over 40 days of instruction.

Class	Addition No Regrouping	Addition With Regrouping	Subtraction No Regrouping	Subtraction With Regrouping	Place Value	Number System	Measurement	Geometry	Word Problems	Other	Total Allocated Time In Mathematics
1	448 (101)	12 (1)	311 (76)	0 (0)	30 (2)	380 (26)	0 (0)	44 (6.5)	149 (10)	49 (7)	1423 (203)
2	641 (28)	8 (4)	590 (38)	0 (0)	158 (28)	336 (31)	0 (0)	0 (0)	155 (16)	13 (11)	1901 (101)
3	563 (60)	13 (1)	374 (54)	0 (0)	294 (22)	623 (53)	5 (2)	8 (2)	69 (7)	0 (0)	1949 (174)
4	285 (54)	20 (11)	129 (40)	0 (0)	149 (40)	253 (42)	109 (30)	103 (38)	0 (0)	0 (0)	1048 (131)
5	446 (40)	12 (2)	489 (52)	0 (0)	150 (17)	362 (49)	0 (0)	0 (0)	49 (23)	0 (0)	1508 (145)
6	242 (79)	27 (19)	289 (100)	0 (0)	16 (3)	132 (52)	147 (116)	45 (26)	62 (35)	0 (0)	960 (73)
Average of Class Means (Unweighted)	437 (154)	15 (7)	364 (162)	0 (0)	133 (101)	348 (163)	43 (67)	33 (40)	81 (60)	10 (20)	1465 (414)

Notes

These data are based on teacher log reports prorated for 40 days of instruction. The row totals correspond to 40 times the average minutes per student per day allocated to mathematics instruction reported in Table 4.1.

Standard deviations are shown in parentheses.

During the A-B period, teachers allocated about 50 percent of their mathematics instruction to addition and subtraction without regrouping, and about twenty-five percent to the number system. Another ten percent of this time was allocated to instruction on place value, the content area on which teachers were asked to concentrate during the OA-OB period. Five of the six classes allocated a substantial amount of time (but generally less than 10 percent of the total allocated time) to word problems. All classes consistently allocated little or no time to the "other" category, and to addition and subtraction with regrouping. Classes 4 and 6 appeared to have slightly more even distributions of time over the content categories, but not remarkably so. In almost all cases, the variability across classes was much greater than that within classes.

The distribution of time allocated to mathematics over the specific content categories is presented in Table 4.9. The allocation pattern among classes in the computation area was relatively homogeneous; teachers generally tended to allocate substantial amounts of time to the same specific content categories. There were, of course some exceptions. For example, only Class 5 allocated a large amount of time to specific category 7 (speed tests/timed drill in subtraction); Class 4 did not allocate time to specific content category 8 (number sentences involving equalities and inequalities); and Classes 4 and 5 allocated very little time to specific content category 25 (missing addends). Classes 1, 3, and 5 allocated considerable time to specific content category 10 (number patterns/sequences), while the remaining classes allocated very little or no time to this category. In the group of categories comprising concepts, Classes 1, 5 and 6 allocated somewhat less time than Classes 2,

Table 4.9

Means and standard deviations for time allocated to specific content categories in mathematics for six grade 2 classes. The entries are class averages reported in minutes per student accumulated over 40 days of instruction.

	COMPUTATION												CONCEPTS												APPLICATION			
Class	1	2	3	4	5	6	7	8	9	10	25	11	12	13	14	15	16	17	18	19	20	21	26	22	23	27	24	Total Time Allocated To Mathematics
1	302 (102)	12 (2)	176 (78)	0 (0)	0 (0)	14 (1)	3 (1)	94 (6)	175 (12)	139 (10)	90 (7)	0 (0)	16 (3)	30 (2)	0 (0)	114 (6)	0 (0)	24 (4)	0 (0)	0 0)	44 (7)	0 (0)	17 (17)	0 (0)	125 (7)	49 (7)	0 (0)	1423 (203)
2	389 (27)	8 (4)	539 (36)	0 (0)	0 (0)	2 (2)	2 (1)	133 (30)	0 (0)	10 (3)	99 (25)	0 (0)	194 (10)	158 (28)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	155 (16)	13 (11)	0 (0)	1901 (101)
3	463 (48)	13 (1)	275 (41)	0 (0)	0 (0)	0 (0)	0 (0)	35 (3)	147 (29)	145 (36)	52 (6)	0 (0)	319 (39)	294 (22)	0 (0)	25 (0)	0 (0)	31 (7)	0 (0)	5 (2)	0 (0)	0 (0)	108 (24)	0 (0)	38 (0)	0 (0)	0 (0)	1949 (174)
4	201 (44)	20 (11)	45 (26)	0 (0)	0 (0)	0 (0)	0 (0)	1 (5)	167 (36)	22 (6)	0 (0)	0 (0)	0 (0)	149 (40)	0 (0)	46 (22)	0 (0)	0 (0)	0 (0)	109 (30)	107 (41)	0 (0)	180 (39)	0 (0)	0 (0)	0 (0)	0 (0)	1048 (131)
5	417 (36)	12 (2)	296 (38)	0 (0)	0 (0)	10 (2)	175 (14)	88 (25)	28 (37)	149 (37)	9 (7)	41 (29)	34 (22)	137 (13)	0 (0)	12 (3)	27 (12)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	24 (11)	49 (23)	0 (0)	0 (0)	1508 (146)
6	105 (33)	27 (19)	147 (23)	0 (0)	0 (0)	17 (5)	22 (5)	89 (30)	125 (27)	0 (0)	115 (142)	11 (7)	0 (0)	16 (3)	27 (36)	32 (18)	0 (0)	0 (0)	124 (97)	17 (13)	0 (0)	23 (13)	0 (0)	28 (17)	22 (22)	0 (0)	12 (16)	960 (73)
age of s Means eighted)	346 (178)	15 (7)	246 (170)	0 (0)	0 (0)	7 (7)	34 (70)	73 (47)	107 (75)	78 (74)	61 (48)	9 (16)	94 (133)	131 (101)	5 (11)	38 (40)	5 (11)	9 (14)	21 (51)	22 (43)	25 (44)	4 (9)	51 (76)	9 (13)	65 (61)	10 (20)	2 (6)	1466 (414)

Notes

The columns of this table are specific content categories. The names of the categories corresponding to the column numbers of the table are presented in Appendix B.

These data are based on teacher log reports prorated for 40 days of instruction. The row totals correspond to 40 times the average minutes per student per day allocated to mathematics instruction reported in Table 4.1.

Standard deviations are shown in parentheses.

3, and 4. Within specific content categories in this latter group, the allocation pattern was heterogeneous. In the applications categories, Classes 1 and 2 received a substantial time allocation to word problems, while the other classes did not.

When interpreting Table 4.9, note that the class averages may not reflect the time allocation for a given student. The within-class standard deviations are of some assistance in assessing the variability among students. In some cases, the standard deviations were considerably greater than the means; this situation arose when most students in the class had almost zero time allocated to a given area while a few students had large allocations. Content categories with relatively small mean times were characterized by these positively skewed distributions. On the other hand, content categories where time was allocated to all students tended to be characterized by negatively skewed distributions. The tail of the distribution often resulted from student absenteeism. Between class variability was, in general, greater than that within classes.

The distribution of time allocated to mathematics in various setting combinations is presented in Table 4.10. The three dichotomous setting variables (adult involvement, pacing, and group size) yield eight three-way combinations, shown in columns 1 through 8. The marginal distributions for the three setting variables are presented in columns 9 through 14. With one exception (Class 2), over 90 percent of time allocated to mathematics had direct adult involvement. About four times as much allocated time was spent in seatwork compared to non-seatwork; and with two exceptions (Classes 3 and 6), almost all of the allocated time was spent in large groups. When the combined settings were examined, all

Table 4.10

Means and standard deviations for time allocated to setting combinations during mathematics in six grade 2 classes. The entries are class averages reported in minutes per student accumulated over 40 days of instruction.

Class	A S L	A S H	A O L	A O H	N S L	N S H	N O L	N O H	A	N	S	O	L	H	Total Time Allocated To Mathematics
1	0 (0)	1033 (35)	3 (7)	314 (42)	0 (0)	8 (1)	64 (157)	0 (0)	1350 (67)	73 (157)	1042 (35)	381 (200)	66 (164)	1356 (64)	1423 (203)
2	0 (0)	924 (52)	1 (2)	190 (29)	0 (0)	786 (60)	0 (0)	0 (0)	1116 (64)	785 (60)	1710 (85)	191 (29)	1 (2)	1900 (101)	1901 (101)
3	297 (95)	1088 (158)	57 (59)	482 (67)	7 (8)	9 (9)	0 (0)	10 (3)	1923 (173)	25 (6)	1401 (140)	548 (46)	361 (131)	1588 (210)	1949 (174)
4	0 (0)	784 (124)	34 (22)	184 (42)	0 (0)	46 (6)	0 (0)	0 (0)	1002 (129)	46 (6)	829 (126)	218 (45)	34 (22)	1014 (139)	1048 (131)
5	20 (22)	1304 (135)	0 (0)	56 (9)	0 (0)	0 (0)	0 (0)	128 (14)	1380 (140)	128 (14)	1324 (135)	184 (20)	20 (22)	1488 (146)	1508 (145)
6	355 (32)	465 (41)	36 (7)	26 (7)	12 (16)	0 (0)	11 (7)	54 (11)	882 (64)	78 (28)	832 (64)	128 (19)	415 (42)	545 (43)	960 (73)
Average of Class Means (Unweighted)	112 (167)	933 (287)	22 (24)	209 (169)	3 (5)	142 (316)	13 (26)	32 (51)	1276 (372)	189 (294)	1190 (350)	275 (159)	150 (187)	1315 (476)	1465 (414)

Notes

The column headings represent combinations of the three setting variables;

adult involvement (A = adult directly involved, N = adult not directly involved),
pacing (S = seatwork, O = non seatwork), and group size (L = small group size, H = large group size).

These data are based on teacher log reports prorated for 40 days of instruction. The row totals correspond to 40 times the average minutes per student per day allocated to mathematics instruction reported in Table 4.1.

Standard deviations are shown in parentheses.

classes allocated more time to large group seatwork with an adult involved than to any other setting. This combination accounted for practically all of the allocated time for Class 5. Classes 1 and 4 allocated the majority of their mathematics instruction time to this large group seatwork with adult involvement combination, but used the large group non-seatwork with adult involvement combination as well. Class 3 was similar to Classes 1 and 4, but also used the small group seatwork with adult involvement combination. Class 6 allocated time more or less evenly to small group seatwork with adult involvement and large group seatwork with adult involvement. Classes 1, 3, 4, 5, and 6 rarely allocated time to a setting where no adult was directly involved. The exception to this pattern was Class 2, where time was allocated fairly evenly between large group seatwork with and without adult involvement. Again, the variability was greater between classes than within classes.

Tables 4.11 and 4.12 show how time was allocated to setting combinations for particular content categories. Data are reported for general content categories 3 and 5 (subtraction without regrouping and place value) in Tables 4.11 and 4.12 respectively. Generally, the patterns of allocation to content category-setting combinations were similar to the patterns for settings. With the exception of Class 6, where no time was allocated to place value, all classes used the large group seatwork with adult involvement combination in both general content categories. Proportionately more time was allocated to this setting for subtraction without regrouping than was the case for place value. The other setting combinations were used in patterns similar to those described in Table 4.10.

Table 4.11

Means and standard deviations of time allocated to setting combinations during instruction on subtraction without regrouping (general content category 3) for six grade 2 classes. The entries are class averages reported in minutes per student accumulated over 40 days of instruction.

Class	A S L	A S H	A 0 L	A 0 H	N S L	N S H	N 0 L	N 0 H	Total Time Allocated To Subtraction Without Regrouping
1	0 (0)	191 (9)	1 (3)	91 (18)	0 (0)	3 (1)	25 (61)	0 (0)	311 (76)
2	0 (0)	299 (20)	0 (1)	56 (12)	0 (0)	234 (18)	0 (0)	0 (0)	590 (38)
3	74 (36)	256 (57)	3 (4)	33 (5)	3 (4)	4 (4)	0 (0)	0 (0)	374 (54)
4	0 (0)	79 (29)	0 (0)	42 (13)	0 (0)	7 (0)	0 (0)	0 (0)	129 (40)
5	10 (10)	349 (45)	0 (0)	12 (2)	0 (0)	0 (0)	0 (0)	118 (14)	489 (52)
6	53 (72)	195 (30)	4 (7)	12 (3)	3 (4)	0 (0)	0 (0)	23 (5)	289 (100)
Average of Class Means (Unweighted)	23 (32)	228 (95)	1 (2)	41 (30)	1 (2)	41 (94)	4 (10)	24 (47)	364 (162)

Notes

The column headings represent combinations of the three setting variables;

adult involvement (A = adult directly involved, N = adult not directly involved), pacing (S = seatwork, 0 = non seatwork), and group size (L = small group size, H = large group size).

These data are based on teacher log reports prorated for 40 days of instruction.

Standard deviations are shown in parentheses.

Means and standard deviations of time allocated to setting combinations during instruction on place value (general content category 5) for six grade 2 classes. The entries are class averages reported in minutes per student accumulated over 40 days of instruction.

Class	A S L	A S H	A O L	A O H	N S L	N S H	N O L	N O H	Total Time Allocated To Place Value
1	0 (0)	14 (0)	0 (0)	16 (2)	0 (0)	0 (0)	0 (0)	0 (0)	30 (2)
2	0 (0)	46 (8)	0 (0)	66 (14)	0 (0)	46 (13)	0 (0)	0 (0)	158 (28)
3	7 (10)	133 (9)	3 (5)	141 (17)	0 (0)	0 (0)	0 (0)	10 (3)	294 (22)
4	0 (0)	34 (9)	34 (22)	72 (29)	0 (0)	9 (0)	0 (0)	0 (0)	149 (40)
5	5 (5)	129 (15)	0 (0)	16 (3)	0 (0)	0 (0)	0 (0)	0 (0)	150 (17)
6	0 (0)	0 (0)	0 (0)	8 (2)	0 (0)	0 (0)	0 (0)	8 (2)	16 (3)
Average of Class Means (Unweighted)	2 (3)	59 (58)	6 (14)	53 (51)	0 (0)	9 (18)	0 (0)	3 (5)	133 (101)

Notes

The column headings represent combinations of the three setting variables;

adult involvement (A = adult directly involved, N = adult not directly involved), pacing (S = seatwork, O = non seatwork), and group size (L = small group size, H = large group size).

These data are based on teacher log reports prorated for 40 days of instruction.

Standard deviations are shown in parentheses.

There were several exceptions; for example, almost no small group settings were used during place value instruction, while small group non-seatwork was used by two classes in both Tables 4.10 and 4.11.

Allocated time data did not necessarily reflect the amount of time students spent engaged in on-task behavior. Table 4.13 presents some information on student engagement during mathematics instruction. Columns A, B, and C, of this table show the means and standard deviations for different engagement indices. The average teacher ratings of student attentiveness were, in every case, higher than either of the averages of the indices based on independent observation procedures. With the exception of Classes 2 and 3, there was close agreement between columns B and C for both means and standard deviations. (Remember that the observation procedure underlying the adjustment for column B was conducted on reading instruction rather than mathematics instruction; this may make comparisons between the columns hazardous.) The correlation between the adjusted teacher ratings of student attentiveness and the observed engagement rates fluctuated around zero for the six classes. Since the number of students within classes was small, none of these correlations appeared to be inordinately large. On the other hand, the correlations between the adjusted teacher ratings of student attentiveness and academic status were all positive and large. This could be interpreted in several ways. It may be that aptitude and student attentiveness were strongly related; or that the teachers' ratings of student attentiveness were strongly biased by teacher perceptions of student aptitude. In any case, the within-class correlations in the table were not affected by the adjustment procedure, since the adjustment coefficient was a constant

Table 4.13

Means, standard deviations and intercorrelations for estimates of student engagement for six grade 2 classes.

		A	B	C	D			
Class	Number of Students	Teacher Ratings of Student Attentive-ness[a]	Adjusted Teacher Ratings of Student Attentive-ness[b]	Observed Engage-ment Rate[c]	Academic Status	r_{BC}	r_{BD}	r_{CD}
1	16	.68 (.22)	.44 (.14)	.47 (.11)	160 (91)	-.12	.70	-.04
2	18	.86 (.08)	.49 (.04)	.74 (.09)	139 (77)	-.25	.57	-.44
3	20	.58 (.16)	.25 (.07)	.44 (.07)	36 (35)	.15	.42	.05
4	14	.69 (.14)	.59 (.12)	.54 (.13)	147 (95)	.33	.42	.28
5	26	.68 (.18)	.41 (.11)	.37 (.08)	133 (66)	-.18	.80	-.17
6	18	.62 (.22)	.51 (.18)	.51 (.12)	75 (47)	.23	.60	-.06
All Students Pooled	112	.68 (.19)	.45 (.15)	.50 (.15)	113 (81)	.27	.57	.05

a The teacher ratings of student attentiveness are described on page 37.

b The adjusted teacher ratings of student attentiveness were obtained by multiplying the teacher ratings of student attentiveness by a different constant for each class. The mean of the adjusted ratings equals the mean class engagement determined by one day of observation in each class (see page 38).

c The observed engagement rate was calculated by taking the ratio for each student of engaged time in mathematics (direct observation) and allocated time in mathematics (observer logs) (see page 37).

within a given class. The observed engagement rates, on the other hand, were derived without reference to students' academic status. If the observed engagement rates are reasonably accurate, this table points out that teacher ratings of student attentiveness were strongly related to academic status, and not to observed engagement rates. In addition, observed engagement rates were uncorrelated with academic status.

Students were engaged in on-task behavior about one half of the time allocated to mathematics. This figure varied considerably from class to class.

Instructional Time and Student Achievement

The conceptual and methodological issues concerning the relationship between instructional time and student achievement are very complex. A relatively large number of models and analytic procedures could be used to investigate the relationship. Several exploratory analyses have been carried out on this data set. Within-class regression analyses were performed, but the small number of students per class made the results unstable, and therefore difficult to interpret. Raw regression weights varied remarkably from class to class and also within class when one or more students were removed. In addition, several interaction terms and alternative definitions for time variables were included in the model, with varying degrees of success. Not all of these analyses are included in this report. Those which are included represent only one relatively narrow approach to the problem.

In every case, achievement scores have been corrected for guessing; however, no other transformations affecting the score intervals have been

made. In some cases, mild ceiling effects have been reduced by trimming subjects rather than by transforming the data in some non-linear fashion. (Other instances of trimming subjects are discussed as they occur.) The time variables are reported in minutes. For allocated time from teacher logs and engaged time from direct observation, the raw data were measured in minutes. In the case of engaged time estimated from teacher logs, the allocated times from teacher logs were multiplied by an observed engagement rate.

In general, results of multiple regression analyses are presented for achievement (post) regressed on achievement (pre), academic status, and a matched time variable. Results of an analysis pooling subjects are followed by results of an analysis where subjects were pooled within class. These analyses are reported for moderately trimmed and also radically trimmed samples (where it seemed that the results after radical trimming might show interesting differences). For analysis of data collected over the A-B period, regression runs were made using allocated times, and rerun using engaged times estimated from allocated times. (In all analyses, estimated engaged times were calculated by taking the product of allocated times from teacher logs and observed engagement rates.) In addition, where analyses were conducted on achievement in place value, the above sequence of analyses was carried out twice: once using matched time variables and once using time variables computed by summing all time in computation and place value.

Results for data collected during the OA-OB period are presented first, followed by results for data collected during the A-B period.

Results from the OA-OB period. The OA-OB period was approximately two weeks in length for each class. Pre and post achievement tests were administered and engaged time was assessed by direct observation for all of the intervening in-school instruction. Means and standard deviations for the achievement measures and engaged time in matched content categories are presented in Table 4.14. During the OA-OB period, teachers were asked to allocate time to place value instruction. Some teachers responded by allocating almost the entire time in mathematics to place value, while others allocated very little. As a result, there was considerable variance in the amount of engaged time in place value. Note from Table 4.14 that, given the short two-week time period, there was also considerable gain in achievement in place value.

For achievement in subtraction without regrouping over the OA-OB period, four classes gained slightly or stayed the same, and two dropped slightly. On the average, there was little change in achievement in subtraction without regrouping. Each class had some engaged time in the matched content category, but both the means and standard deviations were lower than those for engaged time in place value.

Students had essentially zero engaged time in addition with regrouping, and showed no gain in achievement in that area. (Addition with regrouping was just not taught during the early part of Grade 2.) This no time/no learning result supports the more time/more learning hypothesis.

Of the three content areas, place value was the most interesting to pursue, in that an achievement gain had taken place in that area, and there was some variance in engaged time for place value. Hence, the remainder of the results for the OA-OB period are based on the place value data.

Table 4.14

Means and standard deviations for achievement measures and engaged time in matched content categories over the OA-OB period for six grade 2 classes.

Class	Max N	Min N	Academic Status	Place Value			Subtraction Without Regrouping			Addition With Regrouping		
				Pre Test (15 items)	Post Test (15 items)	Engaged Time (minutes)	Pre Test (10 items)	Post Test (10 items)	Engaged Time (minutes)	Pre Test (10 items)	Post Test (10 items)	Engaged Time (minutes)
1	16	16	160.5 (91.1)	6.5 (4.5)	7.3 (5.2)	23 (10)	3.2 (3.1)	2.6 (2.8)	22 (8)	2.5 (2.7)	2.6 (3.3)	1 (1)
2	18	17	138.9 (77.0)	5.4 (1.9)	9.7 (3.3)	176 (45)	3.9 (2.4)	5.0 (2.8)	7 (4)	1.9 (2.4)	1.6 (2.9)	0 (0)
3	20	19	36.4 (35.0)	3.0 (2.4)	1.5 (2.3)	47 (10)	2.3 (2.5)	2.9 (2.9)	45 (14)	0.7 (1.5)	0.0 (1.8)	0 (0)
4	13	12	147.3 (94.7)	5.8 (4.1)	7.8 (4.1)	20 (12)	2.7 (2.9)	2.7 (2.8)	1 (0)	2.6 (2.6)	1.8 (3.1)	0 (0)
5	26	24	133.0 (65.5)	5.5 (3.5)	7.1 (4.1)	13 (7)	4.3 (3.1)	4.3 (3.7)	68 (24)	1.0 (3.2)	1.8 (3.2)	3 (1)
6	18	17	75.3 (47.0)	2.7 (2.4)	3.8 (2.0)	0 (0)	2.3 (1.8)	1.9 (2.6)	43 (18)	1.7 (2.5)	1.3 (3.0)	0 (0)
Average Over Students	112	106	113.3 (80.8)	4.8 (3.4)	6.1 (4.5)	45 (62)	3.2 (2.8)	3.3 (3.1)	35 (28)	1.6 (2.6)	1.5 (2.9)	1 (2)
Average of Class Means (Unweighted)	6	6	115.2 (48.5)	4.8 (1.6)	6.2 (3.0)	47 (65)	3.1 (0.8)	3.2 (1.2)	31 (26)	1.7 (0.8)	1.5 (0.9)	1 (1)

Notes

Engaged time was assessed by direct observation.

Standard deviations are shown in parentheses.

Before analysis of the place value data for the OA-OB period, several cases were deleted from the sample. All of the 112 students had engaged time data, but nine were missing one or more achievement scores. These nine were deleted. No more than three students were dropped from any class. Several students had very high scores on the pre-test. Nine students (no more than three in any class) with scores of 11.0 or greater were trimmed to reduce this ceiling effect. No student who was trimmed because of a high pretest score had a posttest score lower than his pretest score. This moderately trimmed sample of 94 students was used for analysis. All of the runs on the moderately trimmed sample were also carried out on a radically trimmed sample. Classes 3 and 6 were deleted from the sample of 94, yielding a subsample of 59 students.

Class 3 was deleted because serious doubts existed about the motivation of students during the OB posttest. The testing session was not marred by disruption; but students apparently did not try very hard. Few items were omitted, but over half the students had negative raw gain scores, and the class on the whole dropped 1.5 points from pretest to posttest. The item scores for several students were examined and showed that students were getting items wrong on the posttest that they had answered correctly on the pretest. Since the place value scores contained a large amount of measurement error, this class was omitted from the radically trimmed sample. Class 6 had zero variance in engaged time in place value and, as a result, was also trimmed.

Analyses were conducted on both the moderately and radically trimmed samples. Achievement in place value (post) was regressed on achievement in place value (pre), academic status, and engaged time in place value

(general content category 5) assessed by direct observation over the OA-OB period. Tables 4.15 and 4.16 present the results when all subjects were pooled for the moderately and radically trimmed samples, respectively. In both samples, the engaged time in place value had a positive weight which was bounded away from zero. The raw coefficient for engaged time in both cases was about 0.020, indicating that when pretest and academic status were held constant, achievement in place value (post) went up one point for every 50 minutes of engaged time in place value instruction. The partial correlation between engaged time and achievement (post) was higher than that between pretest and posttest in both samples. The percent of variance in posttest uniquely accounted for by engaged time was 10.9 in the larger sample and 17.7 in the smaller sample. The three independent variables jointly accounted for about half (0.49 and 0.41) of the variance in the posttest.

Tables 4.17 and 4.18 present results for analyses of the same variables, when subjects were pooled within class. Each student's scores (on all variables) were deviated from their class means, and the regressions were run on the deviations. The correlation between engaged time in place value and posttest dropped to near zero. The correlations between engaged time in place value and both pretest and academic status remained low in magnitude, but were consistently negative. As expected from the correlations between engaged time and posttest, the raw coefficients for engaged time were not bounded away from zero, although they were positive. In both samples, one percent of variance in posttest was accounted for uniquely by engaged time. The variance in academic status was approximately the same pooled within class as it was for all subjects pooled.

Table 4.15

Achievement in place value (post) regressed on achievement in place value (pre), academic status and engaged time in place value (general content category 5) from direct observation over the OA-OB period (subjects pooled, moderate trim, N = 94).

I DESCRIPTIVE INFORMATION

	Variable	Mean	Standard Deviation	Correlations 1	2	3	4
1	Place Value (Post)	5.3	3.9	1.00			
2	Place Value (Pre)	4.1	2.5	.50	1.00		
3	Academic Status	101.5	73.2	.50	.30	1.00	
4	Engaged Time GCC 5	50.4	66.2	.45	.22	-.12	1.00

II SUMMARY OF MULTIPLE REGRESSION ANALYSIS

Multiple R	0.70	(p = 0.00)[a]
Multiple R Squared	0.49	
Std. Error of Est.	0.83	
Constant	0.33	

Independent Variable	Beta, Stand. Coef-ficient	B, Raw Coef-ficient	Stand. Error Of B	F To Delete	Proba-bility[a]	Partial Corr. With Dep.
Place Value (Pre)	0.3128	0.4840	0.1243	15.15	0.00	0.38
Academic Status	0.3668	0.0196	0.0042	21.54	0.00	0.44
Engaged Time GCC 5	0.3380	0.0199	0.0045	19.22	0.00	0.42

[a] Probabilities rounded to two places.

Table 4.16

Achievement in place value (post) regressed on achievement in place value (pre), academic status and engaged time in place value (general content category 5) from direct observation over the OA-OB period (subjects pooled, radical trim, N = 59).

I DESCRIPTIVE INFORMATION

	Variable	Mean	Standard Deviation	Correlations 1	2	3	4
1	Place Value (Post)	6.9	3.7	1.00			
2	Place Value (Pre)	4.7	2.3	.45	1.00		
3	Academic Status	129.6	72.5	.32	.32	1.00	
4	Engaged Time GCC 5	65.5	77.6	.47	.15	.00	1.00

II SUMMARY OF MULTIPLE REGRESSION ANALYSIS

Multiple R	0.64	(p = 0.00)[a]
Multiple R Squared	0.41	
Std. Error of Est.	2.94	
Constant	1.73	

Independent Variable	Beta, Stand. Coefficient	B, Raw Coefficient	Stand. Error Of B	F To Delete	Probability	Partial Corr. With Dep.
Place Value (Pre)	0.3115	0.4946	0.1759	7.91	0.01	0.35
Academic Status	0.2193	0.0113	0.0056	4.01	0.05	0.26
Engaged Time GCC 5	0.4261	0.0205	0.0050	16.53	0.00	0.48

[a] Probabilities rounded to two places.

Table 4.17

Achievement in place value (post) regressed on achievement in place value (pre), academic status, and engaged time in place value (general content category 5) from direct observation over the OA-OB period (subjects pooled within class, moderate trim, N = 94).

I DESCRIPTIVE INFORMATION

	Variable	Mean	Standard Deviation	Correlations 1	2	3	4
1	Place Value (Post)	0.0[a]	2.9	1.00			
2	Place Value (Pre)	0.0	2.3	.39	1.00		
3	Academic Status	0.0	61.9	.32	.15	1.00	
4	Engaged Time GCC 5	0.0	19.0	.05	-.05	-.06	1.00

II SUMMARY OF MULTIPLE REGRESSION ANALYSIS

Multiple R	0.48	(p = 0.00)[b]
Multiple R Squared	0.23	
Std. Error of Est.	2.58	
Constant	0.00	

Independent Variable	Beta, Stand. Coefficient	B, Raw Coefficient	Stand. Error Of B	F To Delete	Probability[b]	Partial Corr. With Dep.
Place Value (Pre)	0.3518	0.4398	0.1173	14.05	0.00	0.37
Academic Status	0.2704	0.0126	0.0044	8.29	0.01	0.29
Engaged Time GCC 5	0.0853	0.0130	0.0142	0.84	0.64	0.10

[a] Since the scores are mean deviated, all means are equal to zero.

[b] Probabilities are rounded to two places.

Table 4.18

Achievement in place value (post) regressed on achievement in place value (pre), academic status, and engaged time in place value (general content category 5) from direct observation over the OA-OB period (subjects pooled within class, radical trim, N = 59).

I DESCRIPTIVE INFORMATION

	Variable	Mean	Standard Deviation	Correlations 1	2	3	4
1	Place Value (Post)	0.0[a]	3.2	1.00			
2	Place Value (Pre)	0.0	2.3	.41	1.00		
3	Academic Status	0.0	71.8	.35	.31	1.00	
4	Engaged Time GCC 5	0.0	23.5	.03	-.09	-.09	1.00

II SUMMARY OF MULTIPLE REGRESSION ANALYSIS

Multiple R	0.48	(p = 0.00)[b]
Multiple R Squared	0.23	
Std. Error of Est.	2.92	
Constant	0.00	

Independent Variable	Beta, Stand. Coef-ficient	B, Raw Coef-ficient	Stand. Error Of B	F To Delete	Proba-bility[b]	Partial Corr. With Dep.
Place Value (Pre)	0.3436	0.4921	0.1781	7.63	0.01	0.35
Academic Status	0.2529	0.0114	0.0056	4.14	0.04	0.26
Engaged Time GCC 5	0.0839	0.0116	0.0164	0.50	0.51	0.09

[a] Since the scores are mean deviated, all means are equal to zero.

[b] Probabilities are rounded to two places.

However, the variance in engaged time for subjects pooled within class dropped by more than a factor of three when compared to the variance for subjects pooled. For these samples, there was between-class variance in engaged time in place value which was related to achievement in place value; but the relation did not appear when subjects were pooled within class. Figure 4.1 plots class mean raw gain in place value over the OA-OB period against class mean engaged time. Note that Class 2 had very high values on both variables. The results reported for the analysis when subjects were pooled were due, in large part, to this difference between Class 2 and the remaining classes.

Achievement in place value is likely to be related to instruction in addition and subtraction with regrouping, since the skills necessary for computation requiring regrouping are similar to those needed for place value problems. In fact, instruction in addition and subtraction with or without regrouping could be related to place value achievement. To test this possibility, all engaged time in addition and subtraction (both with and without regrouping) and in place value were summed for each student. This composite corresponds to engaged time in general content categories 1 through 5. Regression runs analogous to those described above were conducted. Tables 4.19 and 4.20 present results for the moderately and radically trimmed samples when subjects were pooled.

The correlations between the composite engaged time variable and the posttest were positive but quite low. For the moderately trimmed sample, the raw weight for engaged time was positive and bounded away from zero. In the smaller sample, the raw coefficient was positive but its confidence band included zero. The raw weights in both samples equalled 0.012.

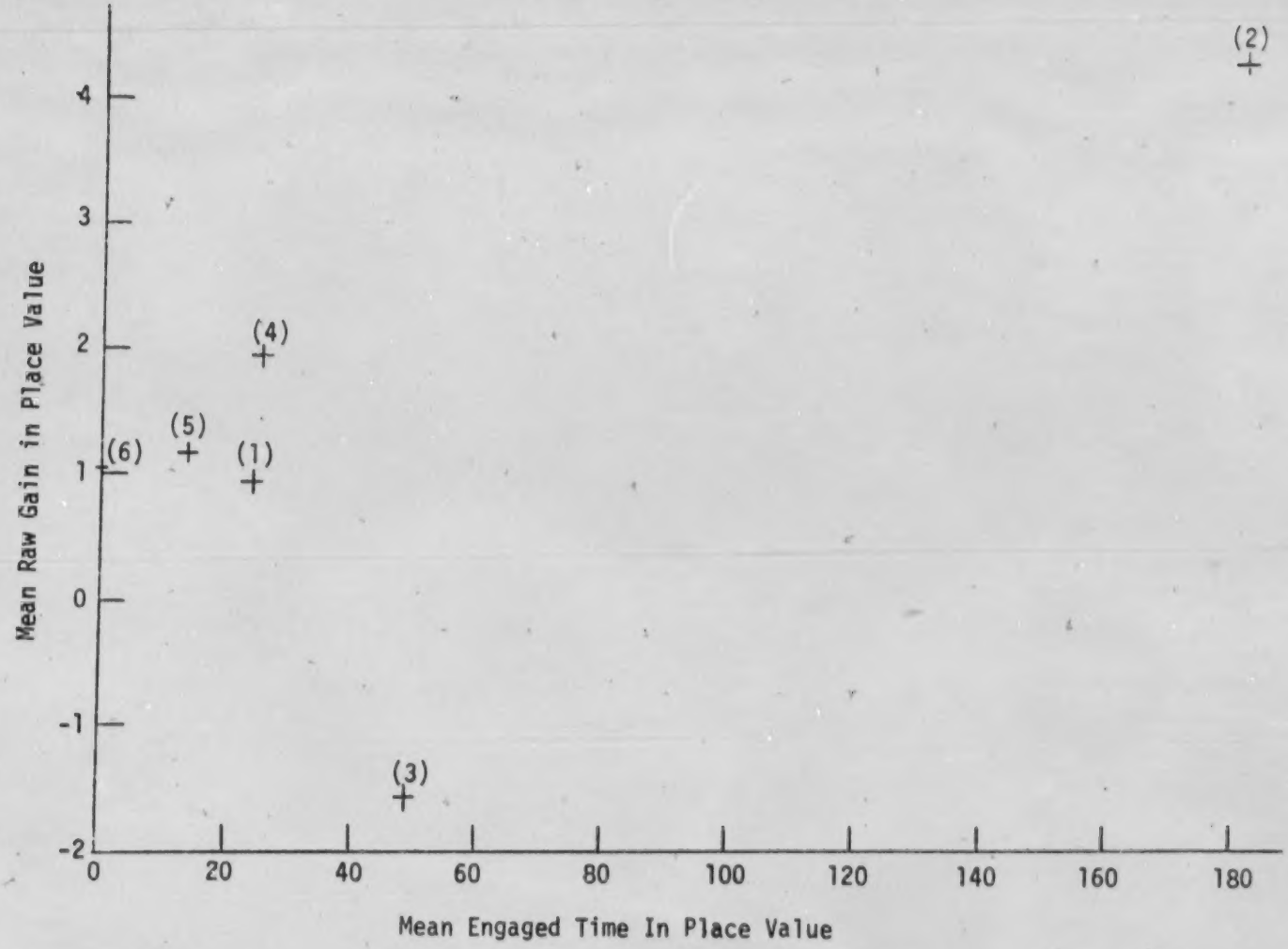


Figure 4.1

Mean raw gain on achievement in place value vs. mean engaged time in place value over the OA-OB period for six grade 2 classes (class identification numbers are shown in parentheses)

Table 4.19

Achievement in place value (post) regressed on achievement in place value (pre), academic status and engaged time summed over general content categories 1 through 5 from direct observation over the OA-OB period (subjects pooled, moderate trim, N = 94).

I DESCRIPTIVE INFORMATION

	Variable	Mean	Standard Deviation	Correlations 1	2	3	4
1	Place Value (Post)	5.3	3.9	1.00			
2	Place Value (Pre)	4.1	2.5	.50	1.00		
3	Academic Status	101.5	73.2	.50	.30	1.00	
4	Engaged Time GCC 1 to 5	136.7	53.9	.23	.13	.01	1.00

II SUMMARY OF MULTIPLE REGRESSION ANALYSIS

Multiple R	0.64	(p = 0.00)[a]
Multiple R Squared	0.41	
Std. Error of Est.	3.04	
Constant	-0.82	

Independent Variable	Beta, Stand. Coef-ficient	B, Raw Coef-ficient	Stand. Error Of B	F To Delete	Proba-bility[a]	Partial Corr. With Dep.
Place Value (Pre)	0.3544	0.5485	0.1323	17.19	0.00	0.40
Academic Status	0.3921	0.0209	0.0045	21.41	0.00	0.44
Engaged Time GCC 1 to 5	0.1773	0.0129	0.0059	4.74	0.03	0.22

[a] Probabilities rounded to two places.

Table 4.20

Achievement in place value (post) regressed on achievement in place value (pre), academic status and engaged time summed over general content categories 1 through 5 from direct observation over the OA-OB period (subjects pooled, radical trim, N = 59).

I DESCRIPTIVE INFORMATION

	Variable	Mean	Standard Deviation	Correlations 1	2	3	4
1	Place Value (Post)	6.9	3.7	1.00			
2	Place Value (Pre)	4.7	2.3	.45	1.00		
3	Academic Status	129.6	72.5	.32	.32	1.00	
4	Engaged Time GCC 1 to 5	149.6	58.4	.16	-.01	-.12	1.00

II SUMMARY OF MULTIPLE REGRESSION ANALYSIS

Multiple R	0.52	(p = 0.00)[a]
Multiple R Squared	0.27	
Std. Error of Est.	3.27	
Constant	0.71	

Independent Variable	Beta, Stand. Coefficient	B, Raw Coefficient	Stand. Error Of B	F To Delete	Probability[a]	Partial Corr. With Dep.
Place Value (Pre)	0.3752	0.5957	0.1933	9.49	0.00	0.38
Academic Status	0.2231	0.0115	0.0063	3.31	0.07	0.24
Engaged Time GCC 1 to 5	0.1948	0.0124	0.0074	2.82	0.10	0.22

[a] Probabilities rounded to two places.

Table 4.21

Achievement in place value (post) regressed on achievement in place value (pre), academic status, and engaged time summed over general content categories 1 through 5 from direct observation over the OA-OB period (subjects pooled within class, moderate trim, N = 94).

I DESCRIPTIVE INFORMATION

	Variable	Mean	Standard Deviation	Correlations 1	2	3	4
1	Place Value (Post)	0.0[a]	2.9	1.00			
2	Place Value (Pre)	0.0	2.3	.39	1.00		
3	Academic Status	0.0	61.9	.32	.15	1.00	
4	Engaged Time GCC 1 to 5	0.0	35.4	-.11	-.05	.10	1.00

II SUMMARY OF MULTIPLE REGRESSION ANALYSIS

Multiple R	0.47	(p = 0.00)[b]
Multiple R Squared	0.22	
Std. Error of Est.	2.59	
Constant	0.00	

Independent Variable	Beta, Stand. Coef-ficient	B, Raw Coef-ficient	Stand. Error Of B	F To Delete	Proba-bility[b]	Partial Corr. With Dep.
Place Value (Pre)	0.3469	0.4337	0.1176	13.60	0.00	0.36
Academic Status	0.2567	0.0121	0.0045	7.25	0.01	0.27
Engaged Time GCC 1 to 5	-0.0532	-0.0044	0.0077	0.32	0.58	-0.06

[a] Since the scores are mean deviated, all means are equal to zero.

[b] Probabilities are rounded to two places.

Table 4.22

Achievement in place value (post) regressed on achievement in place value (pre), academic status, and engaged time summed over general content categories 1 through 5 from direct observation over the OA-OB period (subjects pooled within class, radical trim, N = 59).

I DESCRIPTIVE INFORMATION

	Variable	Mean	Standard Deviation	Correlations 1	2	3	4
1	Place Value (Post)	0.0[a]	3.2	1.00			
2	Place Value (Pre)	0.0	2.3	.41	1.00		
3	Academic Status	0.0	71.8	.35	.31	1.00	
4	Engaged Time GCC 1 to 5	0.0	37.1	-.14	-.13	-.15	1.00

II SUMMARY OF MULTIPLE REGRESSION ANALYSIS

Multiple R	0.48	(p = 0.00)[b]
Multiple R Squared	0.23	
Std. Error of Est.	2.93	
Constant	0.00	

Independent Variable	Beta, Stand. Coef-ficient	B, Raw Coef-ficient	Stand. Error Of B	F To Delete	Proba-bility[b]	Partial Corr. With Dep.
Place Value (Pre)	0.3325	0.4762	0.1790	7.08	0.01	0.34
Academic Status	0.2405	0.0109	0.0057	3.69	0.06	0.25
Engaged Time GCC 1 to 5	-0.0563	-0.0049	0.0105	0.22	0.65	-0.06

[a] Since the scores are mean deviated, all means are equal to zero.

[b] Probabilities are rounded to two places.

In both, three to four percent of the variance in achievement (post) was uniquely accounted for by engaged time. When subjects were pooled within class (Tables 4.21 and 4.22), no relation between engaged time and achievement was found. The correlations between engaged time and achievement (post) were small and negative, while the raw regression weights for engaged time were near zero. Engaged time uniquely accounted for zero percent of the variance on the posttest in analyses where subjects were pooled within class. For this sample, broadening the engaged time category to include more than the matched time weakened the relationship between engaged time and achievement, for analyses where subjects were pooled. For analyses where students were pooled within class, no relationship was detected using either definition of engaged time.

Results from the A-B period. The A-B period was approximately eight weeks in length for each class. Pre and post achievement tests were administered, and allocated time was reported in teacher logs for all of the intervening in-school mathematics instruction. Means and standard deviations for the achievement measures and allocated time in matched content categories are presented in Table 4.23. With the exception of Class 2 (subtraction without regrouping) and Classes 2 and 3 (addition with regrouping) every class gained on all three scales. As in the OA-OB period, very little time was allocated to addition with regrouping, and essentially no achievement gain occurred in that area. Both the place value and subtraction without regrouping scales exhibited considerable growth. The typical variability in allocated time within class was much less than the variability for all subjects pooled, and also much less than the variability in the class means for allocated time. The data on addition

Table 4.23

Means and standard deviations for achievement measures and allocated time in matched content categories over the A-B period for six grade 2 classes.

Class	Max N	Min N	Academic Status	Place Value			Subtraction Without Regrouping			Addition With Regrouping		
				Pre Test (15 items)	Post Test (15 items)	allocated Time (minutes)	Pre Test (10 items)	Post Test (10 items)	allocated Time (minutes)	Pre Test (10 items)	Post Test (10 items)	allocated Time (minutes)
1	16	15	160.5 (91.1)	4.9 (3.6)	7.1 (4.7)	30 (2)	2.3 (1.8)	4.5 (3.1)	311 (76)	1.8 (2.1)	2.4 (3.5)	12 (2)
2	18	18	138.9 (77.0)	2.3 (3.2)	9.7 (2.6)	146 (26)	4.1 (2.4)	5.8 (3.3)	546 (35)	1.3 (2.6)	1.9 (3.4)	7 (3)
3	20	17	36.4 (35.0)	0.7 (2.2)	3.3 (2.8)	272 (21)	1.6 (2.0)	5.2 (3.2)	347 (50)	0.2 (0.9)	1.1 (2.2)	12 (1)
4	14	13	147.3 (94.7)	5.6 (4.3)	7.4 (5.0)	127 (34)	2.5 (2.7)	3.7 (3.7)	109 (34)	1.5 (3.2)	1.1 (2.9)	17 (10)
5	26	23	133.0 (65.5)	4.8 (3.4)	7.8 (3.6)	139 (15)	4.7 (2.8)	5.2 (3.3)	453 (48)	1.8 (3.1)	3.4 (3.8)	11 (2)
6	18	15	75.3 (47.0)	1.2 (1.7)	4.1 (2.4)	15 (3)	3.8 (1.9)	3.5 (3.2)	275 (95)	1.8 (2.1)	0.5 (2.8)	25 (18)
Average Over Students	112	102	113.3 (80.8)	3.3 (3.6)	6.5 (4.1)	127 (88)	3.3 (2.6)	4.7 (3.3)	357 (143)	1.4 (2.5)	1.8 (3.2)	14 (10)
Average of Class Means (Unweighted)	6	6	115.2 (48.5)	3.3 (2.1)	6.6 (2.4)	122 (93)	3.2 (1.2)	4.7 (0.9)	340 (151)	1.4 (0.6)	1.7 (1.1)	14 (6)

Notes

Allocated time was assessed by daily teacher logs.

Standard deviations are shown in parentheses.

with regrouping were not analyzed further. Results for the place value and subtraction without regrouping data are presented in turn.

Before analysis of the place value data, several subjects were dropped from the sample. All 112 students had allocated time data, but 15 were missing one or more achievement scores. The cutting point on pretest used in the OA-OB sample was applied again to reduce a mild ceiling effect. To avoid some artificially large gains, four more students were deleted who had scores of less than -2.0 on the pretest. These students were presumably below the floor of the test. No more than three students in any one class were trimmed to ease ceiling and floor effects. This left a sample of 87 students for analysis. In addition, a radically trimmed subsample was defined. In this case, examination of the frequency distribution of allocated time in place value showed that Classes 1 and 6 allocated essentially no time to place value, and as a result had virtually no within-class variance in time allocated to place value. Trimming these two classes from the sample left 60 students. Analyses are reported for both sample sizes.

Achievement in place value (post) was regressed on achievement in place value (pre), academic status, and allocated time in place value (from teacher logs) over the A-B period. Results for the moderately and radically trimmed samples are presented in Tables 4.24 and 4.25 respectively. Allocated time in place value was negatively correlated with the other variables in both samples. In the smaller sample, the negative correlations were substantial. The raw weights for engaged time were relatively small, and were not bounded away from zero. In both samples, allocated time uniquely accounted for about one percent of the variance

Table 4.24

Achievement in place value (post) regressed on achievement in place value (pre), academic status and allocated time in place value (general content category 5) from teacher logs over the A-B period (subjects pooled, moderate trim, N = 87)

I DESCRIPTIVE INFORMATION

	Variable	Mean	Standard Deviation	Correlations 1	2	3	4
1	Place Value (Post)	6.2	3.7	1.00			
2	Place Value (Pre)	2.8	2.5	.45	1.00		
3	Academic Status	110.8	78.7	.54	.50	1.00	
4	Allocated Time GCC 5	126.9	88.4	-.07	-.21	-.27	1.00

II SUMMARY OF MULTIPLE REGRESSION ANALYSIS

Multiple R	0.59	(p = 0.00)[a]
Multiple R Squared	0.35	
Std. Error of Est.	3.04	
Constant	2.34	

Independent Variable	Beta, Stand. Coef-ficient	B, Raw Coef-ficient	Stand. Error Of B	F To Delete	Proba-bility[a]	Partial Corr. With Dep.
Place Value (Pre)	0.2465	0.3628	0.1510	5.77	0.02	0.25
Academic Status	0.4471	0.0210	0.0049	18.39	0.00	0.43
Allocated Time GCC 5	0.0979	0.0041	0.0039	1.12	0.29	0.12

[a] Probabilities rounded to two places.

Table 4.25

Achievement in place value (post) regressed on achievement in place value (pre), academic status and allocated time in place value (general content category 5) from teacher logs over the A-B period (subjects pooled, radical trim, N = 60)

I DESCRIPTIVE INFORMATION

	Variable	Mean	Standard Deviation	Correlations 1	2	3	4
1	Place Value (Post)	6.5	3.7	1.00			
2	Place Value (Pre)	2.7	2.5	.38	1.00		
3	Academic Status	108.7	74.7	.57	.40	1.00	
4	Allocated Time GCC 5	174.1	64.0	-.40	-.43	-.54	1.00

II SUMMARY OF MULTIPLE REGRESSION ANALYSIS

Multiple R	0.59	(p = 0.00)[a]
Multiple R Squared	0.35	
Std. Error of Est.	3.08	
Constant	4.33	

Independent Variable	Beta, Stand. Coef-ficient	B, Raw Coef-ficient	Stand. Error Of B	F To Delete	Proba-bility[a]	Partial Corr. With Dep.
Place Value (Pre)	0.1491	0.2258	0.1872	1.46	0.23	0.16
Academic Status	0.4561	0.0227	0.0066	11.82	0.00	0.42
Allocated Time GCC 5	0.0867	-0.0051	0.0077	0.43	0.52	-0.09

[a] Probabilities rounded to two places.

in the posttest. When subjects were pooled within class (Tables 4.26 and 4.27), allocated time in place value was negatively correlated with pretest and academic status, but positively correlated with the posttest. The partial correlations for time were positive, but relatively small. The raw regression weights for allocated time in both samples were positive, relatively large (0.026 and 0.027), and approximately twice the size of their standard errors. Allocated time uniquely accounted for 2 percent and 4 percent of the variance in posttest in the large and small samples respectively. In all four runs (Tables 4.24 through 4.27), the three independent variables jointly accounted for about 30 percent of the variance.

The allocated time for place value (from teacher logs) was multiplied by the observed engagement rate (from direct observation and observer logs), thus generating an engaged time estimated from the teacher log data. Regressions, analogous to those just described, were subsequently run on this estimated engaged time. The results for achievement in place value (post) regressed on achievement in place value (pre), academic status, and estimated engaged time in place value with subjects pooled are contained in Tables 4.28 and 4.29. The correlations between estimated engaged time in place value and posttest were 0.12 and 0.00 for the large and small samples respectively. The correlations between estimated engaged time and the remaining variables were negative, and substantially larger in magnitude. The raw weights for estimated engaged time were positive, substantial in size, and bounded away from zero. Estimated engaged time uniquely accounted for 6 percent and 5 percent of the variation in post-test in the two samples, and the partial correlations for estimated

Table 4.26

Achievement in place value (post) regressed on achievement in place value (pre), academic status, and allocated time in place value (general content category 5) from teacher logs over the A-3 period (subjects pooled within class, moderate trim, N = 87).

I DESCRIPTIVE INFORMATION

	Variable	Mean	Standard Deviation	Correlations 1	2	3	4
1	Place Value (Post)	0.0[a]	3.0	1.00			
2	Place Value (Pre)	0.0	2.2	.44	1.00		
3	Academic Status	0.0	66.0	.41	.38	1.00	
4	Allocated Time GCC 5	0.0	18.1	.08	-.19	-.05	1.00

II SUMMARY OF MULTIPLE REGRESSION ANALYSIS

Multiple R	0.54	(p = 0.00)[b]
Multiple R Squared	0.29	
Std. Error of Est.	2.57	
Constant	-0.00	

Independent Variable	Beta, Stand. Coef-ficient	B, Raw Coef-ficient	Stand. Error Of B	F To Delete	Proba-bility[b]	Partial Corr. With Dep.
Place Value (Pre)	0.3641	0.4271	0.1359	12.85	0.00	0.37
Academic Status	0.2828	0.0128	0.0045	8.01	0.01	0.30
Allocated Time GCC 5	0.1591	0.0262	0.0155	2.86	0.09	0.18

[a] Since the scores are mean deviated, all means are equal to zero.

[b] Probabilities are rounded to two places.

Table 4.27

Achievement in place value (post) regressed on achievement in place value (pre), academic status, and allocated time in place value (general content category 5) from teacher logs over the A-B period (subjects pooled within class, radical trim, N = 60).

I DESCRIPTIVE INFORMATION

	Variable	Mean	Standard Deviation	Correlations 1	2	3	4
1	Place Value (Post)	0.0[a]	2.9	1.00			
2	Place Value (Pre)	0.0	2.3	.40	1.00		
3	Academic Status	0.0	61.5	.40	.33	1.00	
4	Allocated Time GCC 5	0.0	21.9	.10	-.24	-.08	1.00

II SUMMARY OF MULTIPLE REGRESSION ANALYSIS

Multiple R	0.53	(p = 0.00)[b]
Multiple R Squared	0.28	
Std. Error of Est.	2.51	
Constant	-0.00	

Independent Variable	Beta, Stand. Coefficient	B, Raw Coefficient	Stand. Error Of B	F To Delete	Probability[b]	Partial Corr. With Dep.
Place Value (Pre)	0.3491	0.4465	0.1580	7.99	0.01	0.35
Academic Status	0.2998	0.0140	0.0056	6.21	0.01	0.32
Allocated Time GCC 5	0.2049	0.0270	0.0154	3.08	0.08	0.23

[a] Since the scores are mean deviated, all means are equal to zero.

[b] Probabilities are rounded to two places.

Table 4.28

Achievement in place value (post) regressed on achievement in place value (pre), academic status and engaged time in place value (general content category 5) estimated from teacher logs over the A-B period (subjects pooled, moderate trim, N = 87).

I DESCRIPTIVE INFORMATION

	Variable	Mean	Standard Deviation	Correlations 1	2	3	4
1	Place Value (Post)	6.2	3.7	1.00			
2	Place Value (Pre)	2.8	2.5	.45	1.00		
3	Academic Status	110.8	78.7	.54	.50	1.00	
4	Est. Engaged Time GCC 5	64.7	47.4	.12	-.21	-.17	1.00

II SUMMARY OF MULTIPLE REGRESSION ANALYSIS

Multiple R	0.63	(p = 0.00)[a]
Multiple R Squared	0.40	
Std. Error of Est.	2.92	
Constant	1.44	

Independent Variable	Beta, Stand. Coef-ficient	B, Raw Coef-ficient	Stand. Error Of B	F To Delete	Proba-bility[a]	Partial Corr. With Dep.
Place Value (Pre)	0.2793	0.4110	0.1458	7.94	0.01	0.30
Academic Status	0.4475	0.0210	0.0046	20.72	0.00	0.45
Est. Engaged Time GCC 5	0.2541	0.0198	0.0068	8.47	0.00	0.30

[a] Probabilities rounded to two places.

Table 4.29

Achievement in place value (post) regressed on achievement in place value (pre), academic status and engaged time in place value (general content category 5) estimated from teacher logs over the A-B period (subjects pooled, radical trim, N = 60).

I DESCRIPTIVE INFORMATION

	Variable	Mean	Standard Deviation	Correlations 1	2	3	4
1	Place Value (Post)	6.5	3.7	1.00			
2	Place Value (Pre)	2.7	2.5	.38	1.00		
3	Academic Status	108.7	74.7	.57	.43	1.00	
4	Est. Engaged Time GCC 5	89.0	36.5	.00	-.40	-.29	1.00

II SUMMARY OF MULTIPLE REGRESSION ANALYSIS

Multiple R	0.63	(p = 0.00)[a]
Multiple R Squared	0.40	
Std. Error of Est.	2.97	
Constant	0.31	

Independent Variable	Beta, Stand. Coefficient	B, Raw Coefficient	Stand. Error Of B	F To Delete	Probability[a]	Partial Corr. With Dep.
Place Value (Pre)	0.2554	0.3869	0.1839	4.43	0.04	0.27
Academic Status	0.5309	0.0265	0.0058	20.85	0.00	0.52
Est. Engaged Time GCC 5	0.2538	0.0259	0.0117	4.92	0.03	0.28

[a] Probabilities rounded to two places.

engaged time were 0.30 and 0.28. In both samples, the independent variables accounted jointly for about 40 percent of the variance.

When subjects were pooled within class (Tables 4.30 and 4.31), the pattern of correlation among the variables changed very little. The raw weights for estimated engaged time were positive and less than twice the size of their standard errors. In both samples, the three independent variables accounted jointly for less than 30 percent of the variance in posttest, and estimated engaged time uniquely accounted for approximately 2 percent of the variance. In this analysis, the partial correlation coefficients for estimated engaged time (0.16 and 0.18) were about half as large as the corresponding coefficients in the analysis where subjects were pooled.

Eight analyses of the relationship between achievement and allocated (or estimated engaged) time in place value have been reported. For analysis where subjects were pooled, no relationship was found between allocated time and achievement in place value, while estimated engaged time in place value showed a relatively strong relationship. The four analyses where subjects were pooled within class were very consistent. A moderate relation was found in each case. The raw coefficients for time were approximately 0.025, with standard errors of approximately 0.015. The unique variance in posttest accounted for by time (allocated or estimated engaged) ranged from 2 to 4 percent. With the other variables held constant, students on the average gained one point in achievement in place value for every 40 minutes of time (allocated or estimated engaged) in place value instruction. The results were similar in the moderately and radically trimmed samples.

Table 4.30

Achievement in place value (post) regressed on achievement in place value (pre), academic status, and engaged time in place value (general content category 5) estimated from teacher logs over the A-B period (subjects pooled within class, moderate trim, N = 87).

I DESCRIPTIVE INFORMATION

	Variable	Mean	Standard Deviation	Correlations 1	2	3	4
1	Place Value (Post)	0.0[a]	3.0	1.00			
2	Place Value (Pre)	0.0	2.2	.44	1.00		
3	Academic Status	0.0	66.0	.41	.38	1.00	
4	Est. Engaged Time GCC 5	0.0	18.0	.06	-.15	-.11	1.00

II SUMMARY OF MULTIPLE REGRESSION ANALYSIS

Multiple R	0.53	(p = 0.00)[b]
Multiple R Squared	0.29	
Std. Error of Est.	2.57	
Constant	0.00	

Independent Variable	Beta, Stand. Coef-ficient	B, Raw Coef-ficient	Stand. Error Of B	F To Delete	Proba-bility[b]	Partial Corr. With Dep.
Place Value (Pre)	0.3520	0.4709	0.1351	12.15	0.00	0.36
Academic Status	0.2952	0.0134	0.0046	8.65	0.01	0.31
Est. Engaged Time GCC 5	0.1431	0.0238	0.0156	2.32	0.13	0.16

[a] Since the scores are mean deviated, all means are equal to zero.

[b] Probabilities are rounded to two places.

Table 4.31

Achievement in place value (post) regressed on achievement in place value (pre), academic status, and engaged time in place value (general content category 5) estimated from teacher logs over the A-B period (subjects pooled within class, radical trim, N = 60).

I DESCRIPTIVE INFORMATION

	Variable	Mean	Standard Deviation	Correlations 1	2	3	4
1	Place Value (Post)	0.0[a]	2.9	1.00			
2	Place Value (Pre)	0.0	2.3	.40	1.00		
3	Academic Status	0.0	61.5	.40	.33	1.00	
4	Est. Engaged Time GCC 5	0.0	21.6	.05	-.20	-.14	1.00

II SUMMARY OF MULTIPLE REGRESSION ANALYSIS

Multiple R	0.51	(p = 0.00)[b]
Multiple R Squared	0.26	
Std. Error of Est.	2.53	
Constant	0.00	

Independent Variable	Beta, Stand. Coef-ficient	B, Raw Coef-ficient	Stand. Error Of B	F To Delete	Proba-bility[b]	Partial Corr. With Dep.
Place Value (Pre)	0.3283	0.4198	0.1577	7.09	0.01	0.34
Academic Status	0.3127	0.0146	0.0057	6.58	0.01	0.32
Est. Engaged Time GCC 5	0.1600	0.0213	0.0156	1.86	0.17	0.18

[a] Since the scores are mean deviated, all means are equal to zero.

[b] Probabilities are rounded to two places.

These eight analyses were repeated using a different definition of the time variable. As in the analyses for the OA-OB period, the relationship between achievement in place value and allocated time in general content categories 1 through 5 was investigated. Allocated time for computation (that is, for addition and subtraction, both with and without regrouping) was added to the time allocated to place value. This broader time variable corresponded to the total time allocated to general content categories 1 through 5.

Tables 4.32 and 4.33 present the results obtained from both samples for achievement in place value (post) regressed on achievement in place value (pre), academic status, and allocated time in general content categories 1 through 5 where subjects were pooled. The raw weights for the broader allocated time variables were smaller than those for allocated time in place value, but were positive and bounded away from zero. The partial correlation coefficients between allocated time and posttest were 0.34 and 0.36 respectively. Allocated time uniquely accounted for 8 percent and the three independent variables accounted for about 40 percent of the variance in posttest in each of the samples. When subjects were pooled within class, (see Tables 4.34 and 4.35) allocated time was unrelated to posttest when pretest and academic status were held constant. In the analyses where subjects were pooled within class, the independent variables jointly accounted for about 25 percent of the variance in posttest.

Similar results were found when estimated engaged time (from teacher logs) in general content categories 1 through 5 was analyzed. There were strong effects for estimated engaged time in analysis where subjects were

Table 4.32

Achievement in place value (post) regressed on achievement in place value (pre), academic status and allocated time summed over general content categories 1 through 5 from teacher logs over the A-B period (subjects pooled, moderate trim, N = 87).

I DESCRIPTIVE INFORMATION

	Variable	Mean	Standard Deviation	Correlations 1	2	3	4
1	Place Value (Post)	6.2	3.7	1.00			
2	Place Value (Pre)	2.8	2.5	.45	1.00		
3	Academic Status	110.8	78.7	.54	.50	1.00	
4	Allocated Time GCC 1 to 5	931.0	319.2	.21	-.15	-.07	1.00

II SUMMARY OF MULTIPLE REGRESSION ANALYSIS

Multiple R	0.64	(p = 0.00)[a]
Multiple R Squared	0.42	
Std. Error of Est.	2.87	
Constant	-0.20	

Independent Variable	Beta, Stand. Coef-ficient	B, Raw Coef-ficient	Stand. Error Of B	F To Delete	Proba-bility[a]	Partial Corr. With Dep.
Place Value (Pre)	0.2786	0.4100	0.1434	8.17	0.01	0.30
Academic Status	0.4258	0.0200	0.0045	19.41	0.00	0.44
Allocated Time GCC 1 to 5	0.2826	0.0033	0.0010	11.08	0.00	0.34

[a] Probabilities rounded to two places.

Table 4.33

Achievement in place value (post) regressed on achievement in place value (pre), academic status and allocated time summed over general content categories 1 through 5 from teacher logs over the A-B period (subjects pooled, radical trim, N = 60).

I DESCRIPTIVE INFORMATION

	Variable	Mean	Standard Deviation	Correlations 1	2	3	4
1	Place Value (Post)	6.5	3.7	1.00			
2	Place Value (Pre)	2.7	2.5	.38	1.00		
3	Academic Status	108.7	74.7	.57	.43	1.00	
4	Allocated Time GCC 1 to 5	1048.5	284.9	.19	-.27	-.09	1.00

II SUMMARY OF MULTIPLE REGRESSION ANALYSIS

Multiple R	0.65	(p = 0.00)[a]
Multiple R Squared	0.43	
Std. Error of Est.	2.89	
Constant	-1.23	

Independent Variable	Beta, Stand. Coef-ficient	B, Raw Coef-ficient	Stand. Error Of B	F To Delete	Proba-bility[a]	Partial Corr. With Dep.
Place Value (Pre)	0.2549	0.3861	0.1759	4.82	0.03	0.28
Academic Status	0.4830	0.0241	0.0056	18.53	0.00	0.50
Allocated Time GCC 1 to 5	0.2992	0.0039	0.0014	8.13	0.01	0.36

[a] Probabilities rounded to two places.

Table 4.34

Achievement in place value (post) regressed on achievement in place value (pre), academic status, and allocated time summed over general content categories 1 through 5 from teacher logs over the A-B period (subjects pooled within class, moderate trim, N = 87).

I DESCRIPTIVE INFORMATION

	Variable	Mean	Standard Deviation	Correlations 1	2	3	4
1	Place Value (Post)	0.0[a]	3.0	1.00			
2	Place Value (Pre)	0.0	2.2	.44	1.00		
3	Academic Status	0.0	66.0	.41	.38	1.00	
4	Allocated Time GCC 1 to 5	0.0	113.9	-.17	-.26	-.30	1.00

II SUMMARY OF MULTIPLE REGRESSION ANALYSIS

Multiple R	0.52	(p = 0.00)[b]
Multiple R Squared	0.27	
Std. Error of Est.	2.61	
Constant	0.00	

Independent Variable	Beta, Stand. Coef-ficient	B, Raw Coef-ficient	Stand. Error Of B	F To Delete	Proba-bility[b]	Partial Corr. With Dep.
Place Value (Pre)	0.3328	0.4453	0.1377	10.45	0.00	0.33
Academic Status	0.2865	0.0130	0.0047	7.56	0.01	0.29
Allocated Time GCC 1 to 5	-0.0016	-0.0000	0.0026	0.00	--	-0.00

[a] Since the scores are mean deviated, all means are equal to zero.

[b] Probabilities are rounded to two places.

Table 4.35

Achievement in place value (post) regressed on achievement in place value (pre), academic status, and allocated time summed over general content categories 1 through 5 from teacher logs over the A-B period (subjects pooled within class, radical trim, N = 60).

I DESCRIPTIVE INFORMATION

	Variable	Mean	Standard Deviation	Correlations 1	2	3	4
1	Place Value (Post)	0.0[a]	2.9	1.00			
2	Place Value (Pre)	0.0	2.3	.40	1.00		
3	Academic Status	0.0	61.5	.40	.33	1.00	
4	Allocated Time GCC 1 to 5	0.0	80.9	-.08	-.17	-.06	1.00

II SUMMARY OF MULTIPLE REGRESSION ANALYSIS

Multiple R	0.49	(p = 0.00)[b]
Multiple R Squared	0.24	
Std. Error of Est.	2.57	
Constant	0.00	

Independent Variable	Beta, Stand. Coefficient	B, Raw Coefficient	Stand. Error Of B	F To Delete	Probability[b]	Partial Corr. With Dep.
Place Value (Pre)	0.2976	0.3807	0.1600	5.66	0.02	0.30
Academic Status	0.3001	0.0141	0.0058	5.90	0.02	0.31
Allocated Time GCC 1 to 5	-0.0153	-0.0005	0.0042	0.02	0.89	-0.02

[a] Since the scores are mean deviated, all means are equal to zero.

[b] Probabilities are rounded to two places.

pooled (see Tables 4.36 and 4.37). The raw coefficients for estimated engaged time were positive, bounded away from zero, and somewhat larger than corresponding coefficients for allocated time. The partial correlations for estimated engaged time were larger than those for any of the other independent variables. The independent variables jointly accounted for about 50 percent of the variance in posttest, while estimated engaged time uniquely accounted for 17 percent of the variance. When students were pooled within class, estimated engaged time was unrelated to posttest. (These latter results are displayed in Tables 4.38 and 4.39.)

Figure 4.2 shows mean raw gain in place value plotted against mean engaged time in place value (estimated from teacher logs). As in Figure 4.1, Class 2 had high values on both variables. The results of analyses where subjects were pooled were due, in large part, to this difference between Class 2 and the remaining classes.

The data on subtraction without regrouping were submitted to similar analysis procedures. As in the case of the place value data, subjects were trimmed from the sample for several reasons. Of the 112 students with allocated time data, 15 were missing one or more achievement scores and were deleted.

The pretest and posttest for subtraction without regrouping were only 10 items long. The frequency distribution of pretest scores showed that several students had attained very high scores. To reduce the ceiling effect, 6 students who had scores greater than 7.5 were deleted from the sample. To help prevent artificially high gains, five more students who had very low pretest scores (less than -1.5) were also deleted.

An examination of the distribution of raw gains was very revealing.

Table 4.36

Achievement in place value (post) regressed on achievement in place value (pre), academic status and engaged time summed over general content categories 1 through 5 estimated from teacher logs over the A-B period (subjects pooled, moderate trim, N = 87).

I DESCRIPTIVE INFORMATION

	Variable	Mean	Standard Deviation	Correlations 1	2	3	4
1	Place Value (Post)	6.2	3.7	1.00			
2	Place Value (Pre)	2.8	2.5	.45	1.00		
3	Academic Status	110.8	78.7	.54	.50	1.00	
4	Est. Engaged Time GCC 1 to 5	-487.8	268.5	.38	-.13	.02	1.00

II SUMMARY OF MULTIPLE REGRESSION ANALYSIS

Multiple R	0.71	(p = 0.00)[a]
Multiple R Squared	0.51	
Std. Error of Est.	2.64	
Constant	0.14	

Independent Variable	Beta, Stand. Coef-ficient	B, Raw Coef-ficient	Stand. Error Of B	F To Delete	Proba-bility[a]	Partial Corr. With Dep.
Place Value (Pre)	0.3139	0.4619	0.1324	12.17	0.00	0.36
Academic Status	0.3790	0.0178	0.0042	18.04	0.00	0.42
Est. Engaged Time GCC 1 to 5	0.4170	0.0057	0.0011	28.47	0.00	0.51

[a] Probabilities rounded to two places.

Table 4.37

Achievement in place value (post) regressed on achievement in place value (pre), academic status and engaged time summed over general content categories 1 through 5 estimated from teacher logs over the A-B period (subjects pooled, radical trim, N = 60).

I DESCRIPTIVE INFORMATION

	Variable	Mean	Standard Deviation	Correlations 1	2	3	4
1	Place Value (Post)	6.5	3.7	1.00			
2	Place Value (Pre)	2.7	2.5	.38	1.00		
3	Academic Status	108.7	74.7	.57	.43	1.00	
4	Est. Engaged Time GCC 1 to 5	562.3	286.4	.41	-.19	.08	1.00

II SUMMARY OF MULTIPLE REGRESSION ANALYSIS

Multiple R	0.72	(p = 0.00)[a]
Multiple R Squared	0.52	
Std. Error of Est.	2.65	
Constant	-0.02	

Independent Variable	Beta, Stand. Coef-ficient	B, Raw Coef-ficient	Stand. Error Of B	F To Delete	Proba-bility[a]	Partial Corr. With Dep.
Place Value (Pre)	0.2901	0.4395	0.1609	7.46	0.01	0.34
Academic Status	0.4054	0.0202	0.0052	15.01	0.00	0.46
Est. Engaged Time GCC 1 to 5	0.4330	0.0056	0.0012	20.33	0.00	0.52

[a] Probabilities rounded to two places.

Table 4.38

Achievement in place value (post) regressed on achievement in place value (pre), academic status, and engaged time summed over general content categories 1 through 5 estimated from teacher logs over the A-B period (subjects pooled within class, moderate trim, N = 87).

I DESCRIPTIVE INFORMATION

	Variable	Mean	Standard Deviation	Correlations 1	2	3	4
1	Place Value (Post)	0.0[a]	3.0	1.00			
2	Place Value (Pre)	0.0	2.2	.44	1.00		
3	Academic Status	0.0	66.0	.41	.38	1.00	
4	Est. Engaged Time GCC 1 to 5	0.0	101.2	-.03	-.16	-.30	1.00

II SUMMARY OF MULTIPLE REGRESSION ANALYSIS

Multiple R	0.53	(p = 0.00)[b]
Multiple R Squared	0.28	
Std. Error of Est.	2.59	
Constant	-0.00	

Independent Variable	Beta, Stand. Coef-ficient	B, Raw Coef-ficient	Stand. Error Of B	F To Delete	Proba-bility[b]	Partial Corr. With Dep.
Place Value (Pre)	0.3396	0.4544	0.1348	11.36	0.00	0.35
Academic Status	0.3213	0.0146	0.0047	9.47	0.00	0.32
Est. Engaged Time GCC 1 to 5	0.1217	0.0036	0.0029	1.54	0.22	0.14

[a] Since the scores are mean deviated, all means are equal to zero.

[b] Probabilities are rounded to two places.

Table 4.39

Achievement in place value (post) regressed on achievement in place value (pre), academic status, and engaged time summed over general content categories 1 through 5 estimated from teacher logs over the A-B period (subjects pooled within class, radical trim, N = 67).

I DESCRIPTIVE INFORMATION

	Variable	Mean	Standard Deviation	Correlations 1	2	3	4
1	Place Value (Post)	0.0[a]	2.9	1.00			
2	Place Value (Pre)	0.0	2.3	.40	1.00		
3	Academic Status	0.0	61.5	.40	.33	1.00	
4	Est. Engaged Time GCC 1 to 5	0.0	104.7	-.05	-.17	-.23	1.00

II SUMMARY OF MULTIPLE REGRESSION ANALYSIS

Multiple R	0.50	(p = 0.00)[b]
Multiple R Squared	0.25	
Std. Error of Est.	2.57	
Constant	-0.00	

Independent Variable	Beta, Stand. Coef-ficient	B, Raw Coef-ficient	Stand. Error Of B	F To Delete	Proba-bility[b]	Partial Corr. With Dep.
Place Value (Pre)	0.3079	0.3938	0.1585	6.18	0.02	0.32
Academic Status	0.3136	0.0147	0.0059	6.27	0.01	0.32
Est. Engaged Time GCC 1 to 5	0.0711	0.0020	0.0033	0.35	0.56	0.08

[a] Since the scores are mean deviated, all means are equal to zero.

[b] Probabilities are rounded to two places.

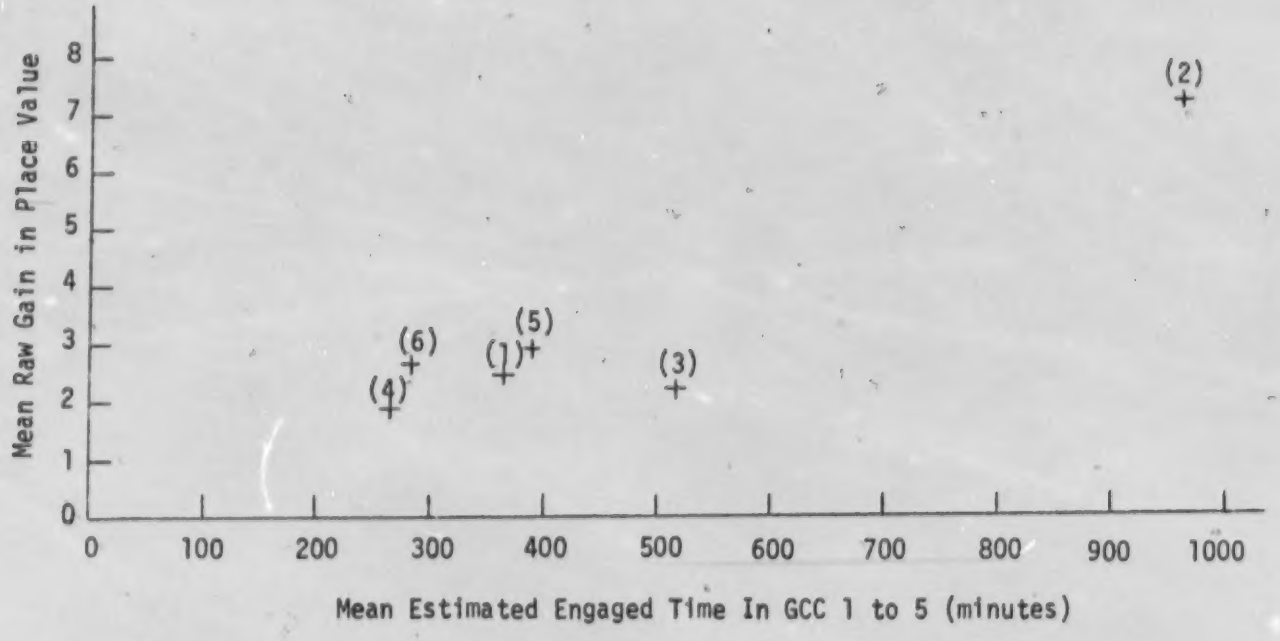


Figure 4.2

Mean raw gain on achievement in place value vs. mean engaged time in general content categories 1 through 5 estimated from teacher logs over the A-B period for six grade 2 classes (class identification numbers are shown in parentheses)

Perhaps as the result of a short test and large measurement error, 40 percent of the students in the untrimmed sample had zero or negative raw gain scores. One or two of the negative raw gains were quite remarkable in size. Four students who had raw gains of less than -5 were deleted. After trimming, 82 students remained in the sample.

Achievement in subtraction without regrouping (post) was regressed on achievement in subtraction without regrouping (pre), academic status, and allocated time in subtraction without regrouping (from teacher logs) over the A-B period. Results for analyses with subjects pooled and for subjects pooled within class are presented in Tables 4.40 and 4.41. In both analyses, allocated time in subtraction without regrouping (general content category 3) was weakly correlated with the posttest. In the analysis where subjects were pooled, allocated time was essentially unrelated to posttest. Pretest and academic status were also only weakly related to posttest, and the three independent variables jointly accounted for only 8 percent of the variance in posttest. The analysis in which students were pooled within class indicated a positive but very weak relationship between allocated time and posttest.

These two analyses of subtraction without regrouping data were repeated for estimated engaged time in subtraction without regrouping (estimated from the teacher logs). In the analysis where subjects were pooled (Table 4.42), a positive but very weak relationship between estimated engaged time and posttest was detected. However, when subjects were pooled within class (Table 4.43), a relatively strong relationship was found. The raw weight for estimated engaged time (0.023) was bounded away from zero and estimated engaged time uniquely accounted for 10 percent of the

Table 4.40

Achievement in subtraction without regrouping (post) regressed on achievement in subtraction without regrouping (pre), academic status, and allocated time in subtraction without regrouping (general content category 3) from teacher logs over the A-B period (subjects pooled, moderate trim, N = 82).

I DESCRIPTIVE INFORMATION

	Variable	Mean	Standard Deviation	Correlations 1	2	3	4
1	Subtraction (Post)	4.9	3.0	1.00			
2	Subtraction (Pre)	3.1	1.9	.24	1.00		
3	Academic Status	116.0	83.3	.17	.25	1.00	
4	Allocated Time GCC 3	368.0	141.4	.09	.01	-.18	1.00

II SUMMARY OF MULTIPLE REGRESSION ANALYSIS

Multiple R	0.29	(p = 0.08)[a]
Multiple R Squared	0.08	
Std. Error of Est.	2.97	
Constant	2.47	

Independent Variable	Beta, Stand. Coef-ficient	B, Raw Coef-ficient	Stand. Error Of B	F To Delete	Proba-bility[a]	Partial Corr. With Dep.
Subtraction (Pre)	0.2025	0.3222	0.1788	3.25	0.07	0.20
Academic Status	0.1378	0.0050	0.0042	1.45	0.23	0.14
Allocated Time GCC 3	0.1099	0.0024	0.0024	0.99	0.68	0.11

[a] Probabilities rounded to two places.

Table 4.41

Achievement in subtraction without regrouping (post) regressed on achievement in subtraction without regrouping (pre), academic status, and allocated time in subtraction without regrouping (general content category 3) from teacher logs over the A-B period (subjects pooled within class, moderate trim, N = 82).

I DESCRIPTIVE INFORMATION

	Variable	Mean	Standard Deviation	Correlations 1	2	3	4
1	Subtraction (Post)	0.0[a]	3.0	1.00			
2	Subtraction (Pre)	0.0	1.8	.28	1.00		
3	Academic Status	0.0	68.2	.30	.27	1.00	
4	Allocated Time GCC 3	0.0	60.2	.03	-.16	-.29	1.00

II SUMMARY OF MULTIPLE REGRESSION ANALYSIS

Multiple R	0.39	(p = 0.01)[b]
Multiple R Squared	0.15	
Std. Error of Est.	2.81	
Constant	-0.00	

Independent Variable	Beta, Stand. Coef-ficient	B, Raw Coef-ficient	Stand. Error Of B	F To Delete	Proba-bility[b]	Partial Corr. With Dep.
Subtraction (Pre)	0.2308	0.3836	0.1805	4.54	0.03	0.23
Academic Status	0.2790	0.0122	0.0049	6.20	0.01	0.27
Allocated Time GCC 3	0.1490	0.0074	0.0054	1.86	0.17	0.15

[a] Since the scores are mean deviated, all means are equal to zero.

[b] Probabilities are rounded to two places.

Table 4.42

Achievement in subtraction without regrouping (post) regressed on achievement in subtraction without regrouping pre), academic status, and engaged time in subtraction without regrouping (general content category 3) estimated from teacher logs over the A-B period (subjects pooled, moderate trim, N = 82).

I DESCRIPTIVE INFORMATION

	Variable	Mean	Standard Deviation	Correlations 1	2	3	4
1	Subtraction (Post)	4.9	3.0	1.00			
2	Subtraction (Pre)	3.1	1.9	.24	1.00		
3	Academic Status	116.0	83.3	.17	.25	1.00	
4	Est. Engaged Time GCC 3	194.1	116.7	.16	.08	-.10	1.00

II SUMMARY OF MULTIPLE REGRESSION ANALYSIS

Multiple R	0.31	(p = 0.05)[a]
Multiple R Squared	0.09	
Std. Error of Est.	2.95	
Constant	2.61	

Independent Variable	Beta, Stand. Coef-ficient	B, Raw Coef-ficient	Stand. Error Of B	F To Delete	Proba-bility[a]	Partial Corr. With Dep.
Subtraction (Pre)	0.1912	0.3041	0.1785	2.90	0.09	0.19
Academic Status	0.1365	0.0050	0.0041	1.48	0.23	0.14
Est. Engaged Time GCC 3	0.1557	0.0041	0.0028	2.04	0.15	0.16

[a] Probabilities rounded to two places.

Table 4.43

Achievement in subtraction without regrouping (post) regressed on achievement in subtraction without regrouping (pre), academic status, and engaged time in subtraction without regrouping (general content category 3) estimated from teacher logs over the A-B period (subjects pooled within class, moderate trim, N = 82).

I DESCRIPTIVE INFORMATION

	Variable	Mean	Standard Deviation	Correlations 1	2	3	4
1	Subtraction (Post)	0.0[a]	3.0	1.00			
2	Subtraction (Pre)	0.0	1.8	.28	1.00		
3	Academic Status	0.0	68.2	.30	.27	1.00	
4	Est. Engaged Time GCC 3	0.0	42.0	.21	-.07	-.30	1.00

II SUMMARY OF MULTIPLE REGRESSION ANALYSIS

Multiple R	0.48	(p = 0.00)[b]
Multiple R Squared	0.23	
Std. Error of Est.	2.68	
Constant	-0.00	

Independent Variable	Beta, Stand. Coef-ficient	B, Raw Coef-ficient	Stand. Error Of B	F To Delete	Proba-bility[b]	Partial Corr. With Dep.
Subtraction (Pre)	0.2141	0.3558	0.1715	4.30	0.04	0.23
Academic Status	0.3363	0.0148	0.0047	9.73	0.00	0.33
Est. Engaged Time GCC 3	0.3249	0.0232	0.0074	9.74	0.00	0.33

[a] Since the scores are mean deviated, all means are equal to zero.

[b] Probabilities are rounded to two places.

Table 4.44

Summary of Results of Regression Analyses for Time Variables and Mathematics Achievement In Six Grade 2 Classes

I RESULTS FOR OA-OB PERIOD (2 weeks)

		SUBJECTS POOLED			SUBJECTS POOLED WITHIN CLASS		
Dependent Variable	Time Variable	Raw Reg. Coefficient	Standard Error of B	Unique Variance Accounted for by Time Variable[a]	Raw Reg. Coefficient	Standard Error of B	Unique Variance Accounted for by Time Variable[a]
Place Value (OB)	Engaged Time Place Value	.0199	.0045	10.8	.0130	.0142	0.7
Place Value (OB)	Engaged Time GCC 1 to 5	.0129	.0059	3.1	-.0044	.0077	0.3

II RESULTS FOR A-B PERIOD (8 weeks)

Place Value (B)	Allocated Time Place Value	.0041	.0039	0.9	.0262	.0155	2.4
Place Value (B)	Estimated Eng. Time Place Value	.0198	.0068	6.4	.0238	.0156	2.0
Place Value (B)	Allocated Time GCC 1 to 5	.0033	.0010	7.8	.0000	.0026	0.0
Place Value (B)	Estimated Eng. Time GCC 1 to 5	.0057	.0011	16.9	.0036	.0029	1.3
Subtraction (B)	Allocated Time GCC 3	.0024	.0024	1.2	.0074	.0054	2.0
Subtraction (B)	Estimated Eng. Time GCC 3	.0041	.0028	2.0	.0232	.0074	9.6

[a] Percent of variance in dependent variable uniquely accounted for by time variable when entered with pretest and academic status.

variance in the posttest. In this case, estimated engaged time accounted for more variance in posttest than either pretest or academic status.

Table 4.44 presents a summary of the relationship found between instructional time and student achievement. For the OA-OB period, a positive relationship was found in analyses where subjects were pooled. Differences between classes in the amount of engaged time in place value were related to student achievement in place value. Over the A-B period, achievement and estimated engaged time were weakly related in analyses where subjects were pooled. Stronger relationships were found when a broader definition of time (especially for estimated engaged time) was used. When subjects were pooled within class, time and achievement in matched content areas were weakly but consistently related. For subtraction without regrouping, estimated engaged time and achievement were strongly related when subjects were pooled within class.

Where substantial relationships were found, time and achievement were positively related. It was also found that, where students had no time in a content area (addition with regrouping), no gain in achievement was observed.

V DISCUSSION

Characteristics of Teacher Allocated Time Logs

The practicality of the teacher log procedure and the accuracy of the recorded allocated time logs were extremely important to this study. The teacher log procedure worked well as a data-collection device. Teachers who grouped students for instruction found the forms easy to use, and in highly individualized classes the procedure was readily adapted.

The best data available for assessing the accuracy of the teacher logs was supplied by the daily logs maintained by observers. But interpretation of comparisons within content categories between these two sources of log data was hampered by two factors. The two sources of log data were categorized at different levels of content (teacher logs used specific content categories while observer logs used general content categories). In addition, the two log procedures used different content coding strategies (teacher logs used multiple coding and observer logs employed focus coding). However, for total time allocated to mathematics, differences due to level of content and coding strategy were irrelevant.

Correlations between the teacher and observer logs were high in four of the six classes; but the mean differences in time allocated to mathematics between the two types of logs were relatively large, for a majority of the teachers. Within content categories, the correlations between teacher and observer logs generally held up for the four classes in which the overall correlations were high. This was true in spite of the differences in coding strategy. In most classes, the variance in allocated

time was relatively small. It appears that students within the same class were allocated similar amounts of time in mathematics, and that the variance in allocated time was strongly influenced by student absences. There was relative consistency between teacher and observer logs on categories where instruction did not occur.

Of the two classes where the overall correlations between teacher logs and observer logs were low, Class 4 requires comment. In this class, instruction was highly individualized. Students worked at four out of approximately 20 "stations" on any given day. At the beginning of the school year, an arrangement was made with the teacher concerning which stations would be coded for mathematics instruction. The teacher presumably restricted recordkeeping to the prearranged stations. The observer, on the other hand, coded everything that was within the bounds of the mathematics categories, regardless of the station at which it occurred. This source of disagreement in the two logs may account, at least in part, for the low correlations within and across content categories in Class 4.

Another possible source of error in the teacher logs was the inconsistency with which some logs were returned to the Far West Laboratory. Logs were to be returned weekly, although the records themselves were entered daily. Some teachers required reminders to return the logs; and, in these cases, it seems safe to assume that the logs might have been completed considerably after the time when the instruction occurred. The intervening time could have varied from one day to one or more weeks. If teachers completed logs well after the fact, they probably relied heavily on lesson plans for the details of instruction. This hypothesized

use of lesson plans (which may or may not have reflected the actual instruction accurately) could well have affected more logs than those which were returned late. In addition, the project staff referred to the logs as "lesson plan logs," which may have influenced teachers. In future work, the logs may be improved by devising procedures to ensure that they are recorded regularly, and are clearly differentiated from the lesson plans which many school districts require as part of their regular operating procedure.

No data were available to check the logs within all specific content categories. In addition, no assessment of the characteristics of the setting codes recorded in teacher logs has been made. These points notwithstanding, the teacher logs compared reasonably well with observer logs.

Results of the comparisons between allocated time from teacher logs and engaged time from direct observation varied from class to class. Classes 1 and 4, which had low overall agreement between teacher and observer logs, showed low correlations between allocated time and engaged time. Because of the low correlation between teacher logs and observer logs, the relation between allocated time and engaged time was difficult to interpret.

Of the four classes which had agreement between teacher logs and observer logs, Classes 2 and 6 had equally high correlations between allocated time and engaged time. For Classes 3 and 5, the correlations between allocated time and engaged time were only half as great as the correlations between teacher logs and observer logs. This would be expected if there were very little variance in the observed engagement

rates within Classes 2 and 6 but relatively large variance within Classes 3 and 5. However, this possibility was not borne out in the data (see Table 4.13). For two of the classes, allocated time was an excellent predictor of engaged time, while in the other two classes allocated time was only moderately related to engaged time.

When allocated time from teacher logs was adjusted (using the teacher ratings of student attentiveness), the correlations between the adjusted allocated time and engaged time from direct observation were lower than than correlations between allocated time and engaged time from direct observation. In general, mean differences between adjusted allocated and engaged time were smaller than those between allocated and engaged time. The adjustment brought the means closer together, but sharply decreased the correlations between allocated and engaged time.

Allocation of Instructional Time in Mathematics

The allocation of time to particular content areas was undoubtedly dependent upon the particular months during which the data were collected. For the October-through-November period, approximately 800 minutes, 350 minutes, and 130 minutes were allocated for the typical student to instruction in addition and subtraction without regrouping, the number system, and place value respectively. These figures represented about 55, 25, and 10 percent of the total time allocated to mathematics. During the A-B period, essentially no time was allocated to instruction in addition and subtraction with regrouping or to the "other" category. Regardless of content category, the variability in allocated time across classes was considerably greater than that within class. The variability

within class was relatively small. This variability arises from differential allocation to students within class (one kind of individualization), and from student absenteeism. For content categories in which most students were allocated instructional time, the distribution of time within class was generally negatively skewed, with a sharp ceiling. This was precisely the distribution to be expected if the variability reflected only student absenteeism. This implies that there was very little variability in allocations of time within class due to individualization. Class 4 was an exception, in that the within-class distributions of allocated time were relatively symmetric. Classes 1 and 6 showed slightly smoother distributions than the remaining three classes. Class 1 apparently had several students in a remedial program who appeared as positive outliers on the allocated time distributions.

There were large differences, in the distributions of allocated time across classes. These differences, in and of themselves, may or may not be important. It remains to be seen whether the differences in time allocation were appropriate. For example, if a class had mastered a particular content area, then large allocations of time to that area would not have been warranted. On the other hand, if a class or some of its members performed at a low level in a particular content area, some time probably should have been allocated to that area.

The distribution of allocated time in mathematics within settings was highly disproportionate. Almost 90 percent of the allocated time was spent in settings with direct adult involvement, and about 80 percent of the time was spent in seatwork. With the exception of Class 2, almost all of the allocated time in mathematics was spent in large group settings.

About 65 percent was spent in large group seatwork with an adult directly involved. This pattern also characterized the distribution of allocated time in setting combinations for place value and subtraction without regrouping, these being the only two general content categories examined.

Students were engaged in on-task activities for approximately half of the time allocated to mathematics. This figure was obtained by direct observation in each of the classes. Student attentiveness was also assessed by teacher ratings. These ratings correlated highly with academic status but not with the observed engagement rates which, in turn, did not correlate with academic status. In this sample, the teacher ratings were apparently biased strongly by student ability, while observed student engagement was independent of both teacher ratings and academic status.

Instructional Time and Student Achievement

Multiple regression analyses relating student achievement and instructional time were reported. Where substantial relationships were found, more time was always associated with higher achievement. For the OA-OB period, between-class differences in engaged time were related to student achievement. No relationship was found when subjects were pooled within class. Over the A-B period, achievement and estimated engaged times in matched content categories were weakly related when subjects were pooled. No relationship was found between allocated time in matched content categories and student achievement. When the time variable was redefined to include time in several related content categories, a stronger relationship with student achievement obtained. This was true for both allocated time and estimated engaged time, although the result was much

stronger for estimated engaged time. When subjects were pooled within class, the matched times consistently showed a relatively weak relationship with achievement, and the more broadly defined time variables were unrelated to achievement. The results for subtraction without regrouping when subjects were pooled within class was an exception. In this case, a relatively strong relation was found between estimated engaged time and student achievement.

The findings for the OA-OB period reflected differences between one class (which spent a large amount of time and attained a large achievement gain) and all other classes (which spent relatively little time and had relatively small achievement gains). Where the differences in engaged time were small (analyses where subjects were pooled within class), no strong relations with achievement were observed. In the only case where large differences occurred (between classes), a relatively strong relationship between engaged time and achievement was found.

For the A-B period, those analyses where subjects were pooled followed the same pattern as the results for the OA-OB period. That is, stronger relationships between time and achievement were found when the between-class differences were large. Class 2, with a large achievement gain and large amount of time, differed from the other classes. When the broader time definition was used, this difference between Class 2 and the other classes was increased.

For the analyses where subjects were pooled within class, the findings over the A-B period differed somewhat from the findings over the OA-OB period. Note that positive, though weak, relationships between time and achievement were found, and that the relationships tended to be stronger for estimated engaged time. A relatively strong relationship was found

in this set of analyses between estimated engaged time and achievement in subtraction without regrouping. Over the A-B period the accumulated differences in time within-class were quite large, and these differences did show a relationship to achievement.

The results obtained from analyses where subjects were pooled provide indirect evidence that more time was related to more learning. However, these effects were essentially between-class effects, and cannot be interpreted unambiguously. There may have been many other differences between classes which would account for the achievement differences. The findings from analyses where subjects were pooled within class can be interpreted more straightforwardly. Though not with consistent strength, instructional time and achievement were positively related, regardless of differences between classes. These results were also supported by the fact that, in cases where no time was allocated to instruction (addition with regrouping), no gain in achievement was detected.

These findings were derived from exploratory analyses. Alternative analysis plans might or might not replicate the results. The underlying model relating time and other factors to learning remains unclear. In the analysis reported here, no consideration was given to possible non-linear relationships. Given more time and resources, a number of interesting hypotheses could be explored. A conceptually simple and intuitively appealing approach assumes that learning is the product of some learning rate and time. With a zero learning rate or no time, no learning takes place. Where learning rate is constant, learning is a function of time; where time is constant, learning is a function of learning rate. Equal amounts of learning may occur as the result of a small amount of time

and a high learning rate, or vice versa. The major difficulty with this notion is the complexity of the "learning rate" concept. Presumably learning rate is a function of the person and of the learning task. In the present case, academic status was taken as an index of student learning rate. In the one case where it was tried, the product of academic status and engaged time when compared with academic status or engaged time alone correlated more highly with both posttest and raw gain. However, the product term is very difficult to interpret, unless the rate measure has a meaningful zero. This product model (or others) was not fully explored for this report.

The way in which content areas are subdivided and categorized may affect the relationship between time and achievement. In this study, mathematics instruction was partitioned into mutually exclusive categories. Achievement tests corresponding to the categories were developed, and relationships were sought between achievement and time within the same category. This certainly appears to be the place to start; however, the task of developing consistent and meaningful content categories is fraught with difficulty. It is tempting to redefine the content categories and to hierarchially structure the manner in which they should be related to a given achievement measure. One attempt at redefinition has been reported; many other plausible alternatives could also be tried.

Since instructional time tended to be allocated in blocks by subject matter, students in the same class tended to have the same total time allocated to mathematics (neglecting any effects due to absenteeism). As a result, the set of content categories for mathematics exhibited

partially ipsative properties. The within-class correlations among mathematics content categories were therefore constrained in a complex fashion. On some occasions, when more than one time variable was entered in a regression analysis, the weights for the variables were opposite in sign. This came about because more time spent on one content category often implied relatively little time spent on another.

The results of this study must, in general, be carefully qualified for a number of reasons. For instance, the achievement measures were relatively short, and therefore prone to sizeable measurement errors. In addition, the teacher log-keeping procedures and the direct observation procedures were developed for the study and, although they had undergone pilot testing, contained relatively large errors. Finally, the sample of classes was small.

Summary and Conclusions

The teacher logs provided a practical procedure for collecting data on allocated instructional time. These logs yielded sufficiently accurate information for both the description of time allocated to content and setting categories and use in analysis of the relationship between instructional time and student achievement. With modifications based on field work and analysis experience gained in this study, the teacher logs warrant continued use. In future work carried out by the Beginning Teacher Evaluation Study, it would be desirable to collect comparable allocated time data from an independent source.

There were large differences between classes in the allocation of time to content categories in mathematics; the differences in such allocation within class were relatively small. A considerable portion

of the within-class variation in time allocation was caused by student absenteeism. Large group seatwork with an adult directly involved was, by far, the most common classroom setting during mathematics instruction. On the average, students were engaged about fifty percent of the time allocated to mathematics instruction. There were large differences in student engagement rates, both within and between classes. Teacher ratings of student attentiveness were not substantially related to observed student engagement rates. In future work of the Beginning Teacher Evaluation Study, it would not be desirable to rely on teacher ratings for estimates of student engagement rates.

Instructional time and student achievement were positively related. Substantial amounts of time and substantial differences in amounts of time were necessary before this relationship could be detected. In future work of the Beginning Teacher Evaluation Study, intertest time periods should be made as long as possible. It would be desirable to focus data collection on content categories which represent substantial portions of the time allocated to a given subject area.

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APPENDIX A

Directions and Examples of Items from Achievement Tests

General Instructions to Testers

Winter Testing, 1975

Teachers

The teacher will be in the room during the testing, mainly to help maintain order. If all is going well, the teacher may work on other things. The BTES staff member is in all cases responsible for administering the test.

At the beginning of the test session, give the teacher a copy of the tests, Say something like "YOU MIGHT WANT TO LOOK THROUGH A COPY OF THE TEST." Let the teacher keep the test during the test session, but be sure to get the test back at the end of the session. Do not let the teacher keep a copy of the test.

Circulating to Check (Not to Help!)

During the testing, it will be necessary to circulate around the room, making sure that students have understood the directions correctly. A student who is confused may raise his hand for help. If this happens (or if you see a child who is not following directions), repeat the instructions to the child. You may point out to him where he is supposed to read and mark. But do not help him answer the questions. And do not read any words for the child during the reading tests.

The teacher may want to help circulate and answer questions. This is permissable as long as the teacher understands that he may only repeat the instructions and may not read words for the child nor try to explain the task more clearly.

Frustrated Children

Some children at lower levels will find the exercises frustrating. Try to encourage such children to figure out what they can. Say something like:

> I KNOW SOME OF THE QUESTIONS ARE DIFFICULT. MAYBE YOU HAVEN'T LEARNED SOME OF THESE THINGS YET. YOU ARE HELPING US FIND OUT WHICH THINGS ARE HARD TO DO. TRY TO FIGURE OUT WHATEVER YOU CAN ON YOUR OWN.

Time Limits

The time limits given for each subtest represent the maximum working time allowed for students after the directions have been given. These times are guidelines, and some leaway is allowed, but it is important not to start running long on each subtest, or total time will be unduly extended. We expect that, in most classes, the majority of students will finish within these limits, while a few students will consistently be slow. When you have to stop students before they finish, tell them:

> IT IS TIME TO STOP. (OR TIME TO GO ON.) IT'S OK IF YOU DIDN'T FINISH. WE JUST WANT TO SEE HOW PEOPLE DO ON THESE EXERCISES.

Try to keep the classroom atmosphere work-oriented but not high-pressured.

Guessing

Do not encourage students to guess randomly. Tell them:

> WORK OUT THE ANSWER AS BEST YOU CAN. THERE MAY BE SOME THINGS YOU DON'T KNOW. IF YOU CAN'T DO IT AT ALL, JUST LEAVE IT BLANK.

Preparation

Past experience has shown the importance of being well prepared for the onslaught of an active group of children. A good strong cup of coffee is often much more valuable than ten more minutes' sleep.

Materials Needed

The tester should go out into the field with:

- test booklets
- scratch paper (2 pieces per student, math only)
- extra pencils
- class list and record form
- watch with second hand
- rubber band

The tester should return to Faye Mueller (phone 565-3011):

- test booklets
- class list
- filled in record form

} enclosed in rubber band

EXAMPLE OF SPECIFIC INSTRUCTIONS FOR TEST BOOKLET 17

GRADE 2 MATH - SELECTED SCALES

Total Time: 20 minutes (Plus Directions)

Make sure desks are clear and students are seated some distance apart.

> GOOD MORNING. TODAY WE WOULD LIKE YOU TO DO SOME MATH (ARITHMETIC) PROBLEMS. WE WANT TO FIND OUT WHAT THINGS ARE EASY AND WHAT THINGS ARE HARD FOR STUDENTS YOUR AGE TO DO. YOU CAN HELP US BY DOING YOUR BEST ON THE PROBLEMS.
>
> WHEN YOU GET YOUR BOOKLET, WRITE YOUR NAME ON THE LINE WHERE IT SAYS NAME. WRITE YOUR LAST NAME FIRST AND THEN YOUR FIRST NAME. PLEASE DO NOT OPEN THE BOOKLETS.

When the children have finished writing their names, state:

> IN THIS TEST, YOU WILL NOT BE WRITING THE ANSWERS. INSTEAD, YOU WILL BE CIRCULING THE LETTER THAT GOES WITH THE ANSWER YOU CHOOSE. LET'S DO AN EXAMPLE TOGETHER. EVERYONE TURN TO THE FIRST PAGE.
>
> THE DIRECTIONS SAY: CIRCLE THE LETTER OF THE ANSWER YOU CHOOSE. THE QUESTION SAYS: HOW MANY DOTS ARE THERE IN THIS PICTURE? LOOK AT THE PICTURE. HOW MANY DOTS ARE THERE? ... YES, THERE ARE 7. WHAT LETTER GOES WITH 7? ... THAT'S RIGHT, THE LETTER B. NOW DRAW A CIRCLE AROUND THE LETTER B TO SHOW US THAT THAT IS YOUR ANSWER. DOES EVERYONE UNDERSTAND THAT YOU NEED TO

CIRCLE THE LETTER THAT GOES WITH YOUR ANSWER? ...

WE ARE GOING TO DO THIS BOOK TOGETHER, PAGE BY PAGE. TURN THE PAGE ONLY WHEN I TELL YOU TO. FOR THE FIRST THREE PAGES, I WILL READ EACH OF THE QUESTIONS OUT LOUD. LISTEN TO THE QUESTION, CIRCLE THE LETTER OF THE ANSWER YOU CHOOSE, AND THEN WAIT FOR ME TO READ THE NEXT QUESTION.

TURN THE PAGE AND WE WILL BEGIN.

Place Value: (7 minutes)

QUESTION #1. Read question. Pause. Repeat question. Pause. Continue in this manner through page 4. However, for the last problem on Page 3 and 4, the answers will also be read out loud to the class.

The reading of these questions should be smoothly paced and each item should take approximately 30 seconds. The transition statement between questions should be: "Question Number_____". Pause. Read Question, etc.

When pages 2, 3, and 4 are finished, have the children turn to page 5.

Page 5 Sample page.

NOW YOU ARE GOING TO DO SOME ARITHMETIC PROBLEMS. BEFORE YOU START, LET'S DO THE EXAMPLE ON THIS PAGE TOGETHER. THE PROBLEM SAYS: 5 - 3 EQUALS WHAT? AN EMPTY BOX. YOU NEED TO FIGURE OUT WHAT NUMBER GOES IN THE EMPTY BOX. WHAT DOES 5 - 3 EQUAL? ... THAT'S RIGHT, 5 - 3 EQUALS 2. FIND THE ANSWER 2. WHAT LETTER GOES WITH THE ANSWER 2? ... YES, THE LETTER C. NOW, DRAW A CIRCLE AROUND THE LETTER C TO SHOW US THAT THAT IS YOUR ANSWER.

ON THE NEXT PAGE THERE ARE SOME PROBLEMS LIKE THESE. I WANT YOU TO DO THE PROBLEMS BY YOURSELF AND WHEN YOU FINISH THE PAGE, STOP. YOU WILL HAVE 6 MINUTES TO DO AS MANY PROBLEMS AS YOU CAN. IF YOU GET STUCK ON A PROBLEM, JUST LEAVE IT AND GO ON TO THE NEXT ONE. YOU MAY USE YOUR SCRATCH PAPER TO FIGURE OUT YOUR ANSWER OR YOU MAY WRITE IN THE BOOKLET.

TURN THE PAGE AND BEGIN.

Page 6 Subtraction (6 minutes)

After 4 minutes, say:

YOU HAVE 2 MINUTES LEFT. TRY TO FINISH UP WHAT YOU CAN.

After 2 more minutes, say:

IT'S TIME TO MOVE ON. EVERYONE TURN TO THE NEXT PAGE.

Page 7 Addition (6 minutes)

> THIS PAGE HAS SOME ADDITION PROBLEMS. YOU HAVE 6 MINUTES TO DO AS MANY PROBLEMS AS YOU CAN. WHEN YOU FINISH THE PAGE, STOP. REMEMBER TO CIRCLE THE LETTER OF THE ANSWER YOU CHOOSE.
>
> YOU MAY BEGIN.

After 4 minutes, say:

> YOU HAVE 2 MINUTES LEFT. TRY TO FINISH UP WHAT YOU CAN.

After 2 more minutes, say:

> IT'S TIME TO STOP. FINISH THE PROBLEM YOU ARE ON AND THEN CLOSE YOUR BOOKLET.

Collect test booklets.

TESTING REPORT FORM
Spring, 1976

Tests Given:_____

Grade Level:_____

Teacher:_____ School:_____

Date:_____ Time:_____

Tester:_____

Number of Students Tested:_____ Number of Students Absent:_____

Conditions of Testing (Problems/Irregularities):

Example Items from Achievement Scales

Scale Name	Number of Items	Description	Example Items
Place Value	15	Place Value with compact or expanded notation. 5 items involve pictorial representation.	Which number means 3 TENS and 2 ONES? A. 23 C. 302 B. 32 D. 320
Subtraction Without Regrouping	10	Subtraction Without Regrouping. Horizontal and vertical format. Includes 4 "missing addend" items. Items range from the subtraction of two 1-digit numbers to two 3-digit numbers.	15 - 8 = ☐ A. 7 C. 13 B. 9 D. 8
Addition With Regrouping	10	Addition With Regrouping. Items include the addition of a 1-digit number with 2-digit number, two 2-digit numbers, and column addition with 1 or 2-digit numbers.	46 +15 A. 51 C. 59 B. 61 D. 62

APPENDIX B

Mathematics Content Categories and Examples of Teacher Logs

General and Specific Content Categories for
Grade 2 Mathematics Instruction

Specific Content Category Number	Category Name	General Content Category Number
	Computation	
1	Addition without regrouping	1
2	Addition with regrouping	2
3	Subtraction without regrouping	3
4	Subtraction with regrouping	4
5	Multiplication - with both factors being less than 10	9
6	Speed tests/timed drill in addition	1
7	Speed tests/timed drill in subtraction	3
8	Number sentences involving equalities and inequalities	6
9	Family of facts/renaming numerals equation form	1,3*
10	Number patterns/sequences	6
25	Missing addends - both in addition and subtraction	1,3*
11	Other - computation**	10
	Concepts	
12	Numerals and ordinals	6
13	Place value with compact or expanded notation	5
14	Fractions involving sets, regions, or lines (1/4,1/3,1/2,2/3,3/4)	9
15	Properties (associative, commutative, and identity elements)	6
16	Associative property with expanded notation	5,6*
17	Money	9
18	Linear measurements	7
19	Measurement concepts: order, capacity, conservation of length	7
20	Geometric figures:	8
21	Curves and points	8
26	Developmental activities	6
22	Other - concepts**	10

Specific Content Category Number	Category Name	General Content Category Number
	Applications	
23	Word problems	9
27	Standardized tests	10
24	Other - applications**	10

*Specific content categories 9,16, and 25 are logically related to two general content categories. In each case time in a specific content category was divided equally and assigned to the appropriate general content categories.

**Time in specific categories 11,22,24 was assigned to general content category 10 if it was not clear that the event could be assigned to general content categories 1-9.

General Content Categories

General Content Category Number	Category Name	Observation Content Category Number
1	Addition without regrouping	1
2	Addition with regrouping	2
3	Subtraction without regrouping	3
4	Subtraction with regrouping	4
5	Place value	5
6	Number system	6
7	Measurement	
8	Geometry	
9	Word problems	
10	Other	

Glossary: Selected Specific Content Categories

SCC 8 Number sentences: equalities and inequalities
Determining what sign is missing in an equation or number sentence.
Primarily involving the signs of $>$, $<$, and $=$. But may also involve + and −.

Examples: $5 \bigcirc 4$
$2 + 1 \bigcirc 3$
$3 \bigcirc 4 = 7$

SCC 9 Family of Facts (renaming numberals, equation form)

Example: Given 2 addends and a sum, write all the equations possible.

$3 + 2 = 5$ $\quad$ $5 - 2 = 3$
$2 + 3 = 5$ $\quad$ $5 - 3 = 2$

Write n equations renaming the numeral 7.

$4 + 3 = 7$ $\quad$ $9 - 2 = 7$
$5 + 2 = 7$ $\quad$ $8 - 1 = 7$ $\quad$ etc.
$6 + 1 = 7$ $\quad$ $10 - 3 = 7$

SCC 10 Number patterns
Emphasis is on completing the pattern and/or discovering the rule.
May ask "What is the next number?" or "What rule did you use to find the missing number?"

Examples: a. 2, 4, 6, ?, ?, 12 (series)

b.

	2	3	4	?	?
	4	6	?	?	12

(input/output function)

c.

4	?	10	
3	5	?	
?			18

(magic squares)

d. [(1,3) (2,4) (?,5) (?,?)] (set of number pairs)

SCC 15 Properties
Situations often arise in the teaching of basic facts, computation, etc. where particular items may illustrate certain basic properties. However, for the log, we are interested in lesson segments where attention is given or drawn to a particular property or the lesson involves a series of computational items which involve application/use of a property.

SCC 15 (cont'd)

1. Commutative (order): emphasis or attention at this stage is focused on the reversability of order.

   Examples: $2 + 4 = 4 + 2$
   $3 \times 2 = 2 \times 3$
   or $6 + 1 = 7,\ 1 + 6 = 7$ (When these equations appear together and attention is drawn to reversability)

2. Associative (grouping): manner in which numbers are grouped does not affect sum.

   Examples: $(2 + 3) + 5 = 5 + 5$
   $2 + (3 + 5) = (2 + 3) + 5$

   or can be combined with expanded notation:

   $78 + 2 = 70 + (8 + 2)$
   $= 70 + 10$
   $= 80$

   $38 = 30 + 8$ so
   $38 - 5 = (30 + 8) - 5$
   $= 30 + (8 - 5)$
   $= 30 + 3$
   $= 33$

3. Inverse: Addition is inverse of subtraction.

   Examples: $13 + 1 = 14$
   $14 - 1 = 13$

   $\begin{array}{r} 91 \\ -47 \\ \hline 44 \end{array}$ $\begin{array}{r} 44 \\ +47 \\ \hline 91 \end{array}$

4. Identity elements: zero for addition and subtraction, one for multiplication.

   Examples: $3 + 0 = 3$
   $4 - 0 = 4$
   $1 \times 6 = 6$

Example: Attendance/Group Composition Record

READING (MATH) (circle one) Teacher No. 3 Grade 2

Student's Name	Group	Week of October 27-31, 1975				
		M	T	W	Th	F
1. ID # 239	3					
2. ID # 240	2					
3. ID # 241	2	Absent				
4. ID # 242	3					
5. ID # 243	3			Absent		
6. ID # 247	2					
7. ID # 251	3				No Absences	No Absences
8. ID # 252	2					
9. ID # 253	2					
10. ID # 254	3					
11. ID # 255	3					
12. ID # 256	2					
13. ID # 257	2			Absent		
14. ID # 258	2					
15. ID # 259	2					
16. ID # 260	3					
17. ID # 262	3					
18. ID # 263	2					
19. ID # 264	2					
20. ID # 265	3					
21. ID # 266	3					
22.						
23.						
24.						
25.						
26.						
27.						
28.						
29.						
30.						
31.						
32.						
33.						
34.						

EXAMPLE: Teacher Log

TEACHER No. 3 GRADE 2 READING ____ MATH x GROUP 2 and 3 WEEK 10-27 to 31

TIME: 10:50 - 11:50

MONDAY	CONTENT	#10 20 mins.	#13 20 mins.	#10 10 mins.
	Adult / No Adult and Seatwork / Other	A & S	A & S	A & O
	MATERIAL	Ditto write by 2's, 5's, 10's	Mod. math page 97-98	Board explanation by teacher with students participating at board
TUESDAY	CONTENT	#10	#1 #3	
	Adult / No Adult and Seatwork / Other	A & S	A & S	
	MATERIAL	Mod. math pages 99-100	Mod. math 101-102	
WEDNESDAY	CONTENT	#12	#10 20 mins.	#1 #3 15 mins.
	Adult / No Adult and Seatwork / Other	A & S	A & S	N & S
	MATERIAL	Ditto #2 Number names	Ditto: write to 100. Label even numbers with blue crayon	Color by number ditto(attached) + and - facts
THURSDAY	CONTENT	#12 #10	#10 #13	
	Adult / No Adult and Seatwork / Other	A S	A & S & O	
	MATERIAL	Ditto #3 used sticks sets and straws to do their work.	Correcting errors on papers - students working together in small groups with counters and sets of 10.	
FRIDAY	CONTENT			
	Adult / No Adult and Seatwork / Other	HALLOWEEN PARADE		
	MATERIAL			

APPENDIX C

Teacher Rating Forms

Rating of Student Attentiveness

The lesson plan logs tell us how much time was allocated by the teacher to different settings and objectives in reading or mathematics. But there is often a difference between the amount of time taken up by a lesson and the amount of time which is active learning time for a student. We would like to get a more accurate estimate of the amount of actual learning time for an individual student. This will be used as a "correction factor" in the interpretation of the log information.

A student who is paying attention	works actively on assignments participates or listens attentively during class discussion
A student who is not paying attention	talks to his neighbor daydreams draws pictures on his paper falls asleep walks around the room waits for help

Children differ in the amount of time they pay attention in class. Based on your observations of the children so far this year, please rate each child in your class as to the percentage of time that child generally pays attention. Think only of the subject matter for which you are keeping logs. If you are keeping math logs, think about how much of the time a student pays attention during math lessons. If you are keeping reading logs, think of the time you record as reading or reading related.

We suspect that children may differ in attentiveness depending on whether or not an adult is present. For this reason, we would like you to rate each child twice. First rate the children for settings in which an adult is present (either seatwork with an adult supervising or group work with an adult). Then rate the children a second time for settings with no adult present.

One way to go about this task is to go through the following steps:

1. Think of a typical 40 or 50 minute lesson period. Think first of settings where an adult is present to supervise and encourage attention. During what percentage of the time would a student by likely to pay attention to the lesson? On the form labeled "Adult Present," assign each student a rating.
2. Shift your thinking to a 40 or 50 minute period where the students are left to work on their own without an adult. What percentage of the time would a student be likely to pay attention under these conditions? Record your ratings on the form labeled "No Adult."

Use as many or as few of the categories as you wish to indicate the differences in attentiveness among your students. The descriptions below may help as guidelines.

91-100%	The child almost always attends to the learning task.
71-80%	The child sometimes loses time through temporary inattention or general classroom disruption but he tends to work more often than not.
51-60%	The child is as likely to be distracted as he is to work. Only about half the period is spent attending to the task.
21-30%	The child is frequently distracted and inattentive. Large periods of time may be lost through inattention. The child may be noticeably disruptive in class or may simply daydream a lot.
0-10%	The child almost never attends to the learning task.

Teacher's Name_____

Rating of Student Attentiveness

PUT A CHECK IN THE APPROPRIATE BOX

Adult Present

Student	0-10%	11-20%	21-30%	41-50%	51-60%	61-70%	71-80%	81-90%	91-100%

Teacher's Name_____

Rating of Student Attentiveness

PUT A CHECK IN THE APPROPRIATE BOX

Student	No Adult 0-10%	11-20%	21-30%	41-50%	51-60%	61-70%	71-80%	81-90%	91-100%